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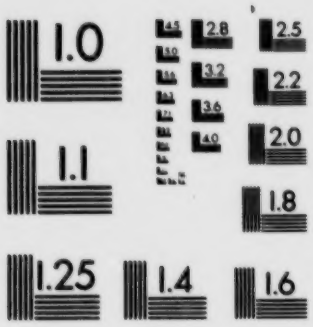

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ENERGY CONSERVATION
FOR NORTHERN SASKATCHEWAN SCHOOLS

ENERGY CONSERVATION FOR NORTHERN SASKATCHEWAN SCHOOLS

Stony Rapids, Brabant Lake and Camsell Portage

Prepared for:

Northern Lights School Division, Saskatchewan

Prepared by:

Eneraction Resources, Inc.

With a contribution from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

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EXECUTIVE SUMMARY

This study has been prepared for the Northern Lights School Division. The objectives of the study were to prepare an energy profile of three northern schools, a ranking of energy conservation options for each school, and a manual detailing an implementation plan and energy budget for each school. In this way the Northern Schools may take advantage of energy conserving options and reduce the substantial yearly energy bill.

Each school was energy audited during the week of December 10, 1984. The average outside temperature at the time of the audit was approximately -40^{0}C. The audit procedures for each school included:

- A thorough review of the energy bills for the past three years.
- A study of the architectural, mechanical and electrical drawings.
- A familiarization of the maintenance and operations manuals.
- An interview with the school principal.
- An interview with the school maintenance personnel.
- An on-site survey and extensive inspection of the school.

The findings for **Brabant Lake School** were generally as follows:

- Well maintained.
- New and efficient energy systems.
- Electric heaters installed in vestibules and crawlspaces.
- Ventilating systems needed attention and are wasting energy.
- Night setback thermostats and delamping will save a significant amount of energy.

The findings for **Camsell Portage School** were as follows:

- No regular maintenance.
- Energy systems were in poor condition. One furnace is being replaced due to a cracked heat exchanger and the other furnace is an older inefficient model.
- Both furnaces should be replaced with high efficiency oil burning furnaces.
- Night setback thermostats should be installed.
- Lighting system should use low wattage long-life tubes.

The findings for **Stony Rapids School** were generally as follows:

- Moderately maintained.
- The energy systems range from old and inefficient to modern and highly efficient.
- The older furnaces should be upgraded to modern efficient furnaces.
- Automating the industrial arts room ventilation will save a substantial amount of energy.
- The gymnasium ventilation system is not correctly controlled and school staff are not aware of the proper operation of the controls.
- Night setback thermostats and delamping provide paybacks of six months or less.

Details of each schools' findings and recommendations are contained within the report. All the recommendations have a payback of five years or less and can be implemented by school staff or maintenance personnel.

Some generic findings from the schools were:

- Ventilation systems needing more attention and checking to ensure proper functioning.
- Old inefficient oil furnaces should be replaced with new efficient furnaces or where feasible with high efficiency propane furnaces.
- All single pane windows in wood frames [which require annual caulking] should be replaced with double pane windows in thermally efficient frames.
- Water efficient shower heads should be installed to minimize hot water consumption on the average yield a pay-back of three (3) months.
- Night setback thermostats will significantly reduce energy consumption.
- Delamping and/or relamping with low wattage tubes will save electrical energy and on the average be paid back in two (2) years.
- Caretakers must be instructed to vacuum furnace filters once a month.

In most cases the above findings and recommendations can be applied to all the schools in the Northern Lights School District.

PROGRAMME D'ÉCONOMIE DE L'ÉNERGIE POUR LES ÉCOLES DU NORD DE LA SASKATCHEWAN DANS LES COLLECTIVITÉS DE STONY RAPIDS, BRABANT LAKE ET CAMSELL PORTAGE

Résumé

Cette étude a été préparée pour la Northern Lights School Division. Cette étude avait pour but d'établir le profil énergétique de trois écoles du nord de la Saskatchewan, d'élaborer un manuel donnant les détails d'un plan de mise en oeuvre et d'un budget énergétique pour chaque école. De cette façon, les écoles du nord de la Saskatchewan peuvent maintenant tirer profit des options d'économies d'énergies qui leur sont offertes et réduire leur facture énergétique annuelle qui est importante.

Une vérification énergétique a été effectuée dans chaque école dans la semaine du 10 décembre 1984. La température extérieure moyenne atteignait à cette période approximativement -40°C.

La méthode de vérification employée pour chaque école comprenait les points suivants:

- l'étude approfondie des factures énergétiques des trois dernières années;
- l'étude des plans du point de vue architectural, mécanique et électrique;
- la revue des manuels d'entretien et de fonctionnement;
- une entrevue avec le directeur de l'école;
- une entrevue avec le personnel responsable de l'entretien de l'école;
- une inspection sur le terrain ainsi qu'une inspection approfondie de l'école.

La petite école (739 m^2) du nom d'Ospawakum est située à Brabant Lake et accueille quotidiennement une moyenne de 45 à 60 élèves. La consommation en électricité a augmenté de 70% entre 1982 et 1983 (de 53 160 kWh pour un total de 18 360 $ elle est passée à 91 680 kWh nécessitant des déboursés de 33 940 $). Au cours de la même période, la consommation de mazout a chuté de 60% (soit de 29 995 litres pour un total de 9 290 $ à 11 797 litres pour un total de 5 510 $).

Les constatations générales auxquelles nous sommes parvenus dans le cas de l'école Brabant s'énoncent comme suit:

- bon entretien
- des systèmes énergétiques neufs et efficaces;
- présence de chaufferettes électriques dans les vestibules et les endroits fréquentés;
- nécessité de contrôler les systèmes de ventilation car ils gaspillent de l'énergie;
- le réglage à la baisse des thermostats pour la nuit et le remplacement du système d'éclairage permettront de faire des économies d'énergies considérables.

La consommation et les coûts de l'énergie de la minuscule école (192 m^2) de Camsell Portage ont baissé entre 1982 et 1983 (en 1982, la consommation en électricité et en mazout est passée respectivement de 22 498 kWh et de 9 923 litres pour un total combiné de 11 202 $ à 13 325 kWh et à 9 317 litres pour un total combiné de 9 401 $ en 1983).

Les constations auxquelles nous sommes parvenus concernant l'école Camsell Portage sont les suivantes:

- pas d'entretien régulier;
- les systèmes énergétiques sont en médiocre condition. Une chaudière doit être remplacée parce qu'un échangeur de chaleur est fendu, quant à l'autre chaudière, il s'agit d'un vieux modèle à faible rendement;
- les deux chaudières devraient être remplacées par des chaudières alimentées au mazout et à haut rendement;
- des régulateurs de température devraient être installés;
- procéder à l'installation de néons à bas wattage et à longue durée.

Stony Rapids possède la plus grande école des trois collectivités (2 061 m^2). Elle accueille quotidiennement de 80 à 90 élèves. La consommation et les coûts de l'énergie ont baissé entre 1982 et 1983 (en 1982, la consommation d'électricité est passée de 117 600 kWh, celle de mazout de 102 060 litres pour un total combiné de 70 620 $ à 112 870 kWh et 94 350 litres pour un total combiné de 66 240 $ en 1983).

Les constatations générales auxquelles nous sommes parvenus concernant l'école Stony Rapids sont les suivantes:

- entretien moyen;
- les systèmes énergétiques en place vont du système vétuste et innefficace au système moderne et hautement efficace;
- les vielles chaudières devraient être remplacées par de nouvelles chaudières, plus efficaces;

- le fait d'automatiser la ventilation dans les salles de techniques permettra de faire des économies d'énergies appréciables;

- le système de ventilation du gymnase n'est pas proprement contrôlé et le personnel de l'école ne sait pas le faire fonctionner correctement;

- La période de recouvrement concernant l'installation de régulateurs de température et le remplacement du système d'éclairage est de six mois ou moins.

Les recommandations et les constations faites pour chaque école sont élaborées en détails dans le rapport. Toutes les recommandations ont une période de recouvrement de cinq ans ou moins et peuvent être appliquées par le personnel de l'école ou par le personnel responsable de l'entretien.

Ces mesures comprennent entre autres:

- la vérification périodique des systèmes de ventilation pour s'assurer qu'ils fonctionnent adéquatement;

- le remplacement de chaudières au mazout à faible rendement par de nouvelles chaudières à haut rendement ou par des chaudières au propane à haut rendement, lorsque cela est possible;

- le remplacement des fenêtres d'une épaisseur dont le cadre est en bois (et qui exige un calfeutrage annuel) par des fenêtres à double épaisseur dont les cadres ont un haut rendement thermique;

- l'installation de pommes de douche à haut rendement pour diminuer la consommation d'eau chaude (et dont le recouvrement moyen est de trois mois);

- baisse de la température la nuit;

- le remplacement du système d'éclairage ou la mise en place de néons à bas wattage (recouvrement moyen de deux ans);

- le nettoyage mensuel à l'aspirateur des filtres de chaudière.

Dans la plupart des cas, les constatations et les recommandations qui précèdent peuvent s'appliquer à toutes les écoles du district Nothern Lights.

L'étude indique qu'un bâtiment à haut rendement énergétique ne suffit pas à économiser de l'énergie et des sommes d'argent. L'énergie consommée en trop est le résultat de mauvaises pratiques de la part des utilisateurs, les bâtiments ne présentant pas de problèmes réels. Le personnel responsable de l'entretien et le personnel enseignant devraient savoir comment utiliser les appareils de chauffage et de ventilation.

Cette étude a été préparée pour la Northern Lights School Division par Eneraction Resources Inc. et a été financée par Énergie, Mines et Ressources Canada dans le cadre du Programme de démonstration dans les collectivités éloignées.

ENERGY CONSERVATION FOR NORTHERN SCHOOLS -

1.0 Introduction

The objective of the "Energy Conservation for Northern Schools" study is to identify specific opportunities for energy conservation in three schools located in Brabant Lake, Camsell Portage and Stony Rapids. The report on each school is presented in an identical sequence.

The sequence is as follows:

- A description of the school s, size, present energy consumption and occupancy levels.
- A summary of the on-site audit, room by room inspection.
- An examination of the present maintenance practices and the equipment manufacturers recommended maintenance practices followed by the audit teams observations and recommendations regarding maintenance practices.
- Recommendations for energy conservation through school operations and maintenance practices.
- Recommended capital investments that result in energy conservation with each option having a simple payback of less than 5 years.
- A plan and timetable for implementing energy conservation.
- Presentation of the school's energy budget and a plan for monitoring fuel consumption.

The appendices include the complete findings from the room by room inspection as well as a section on general maintenance. This section has detailed information regarding lighting requirements, furnace efficiency analysis data, manufacturer's maintenance requirements and information on energy efficient shower heads.

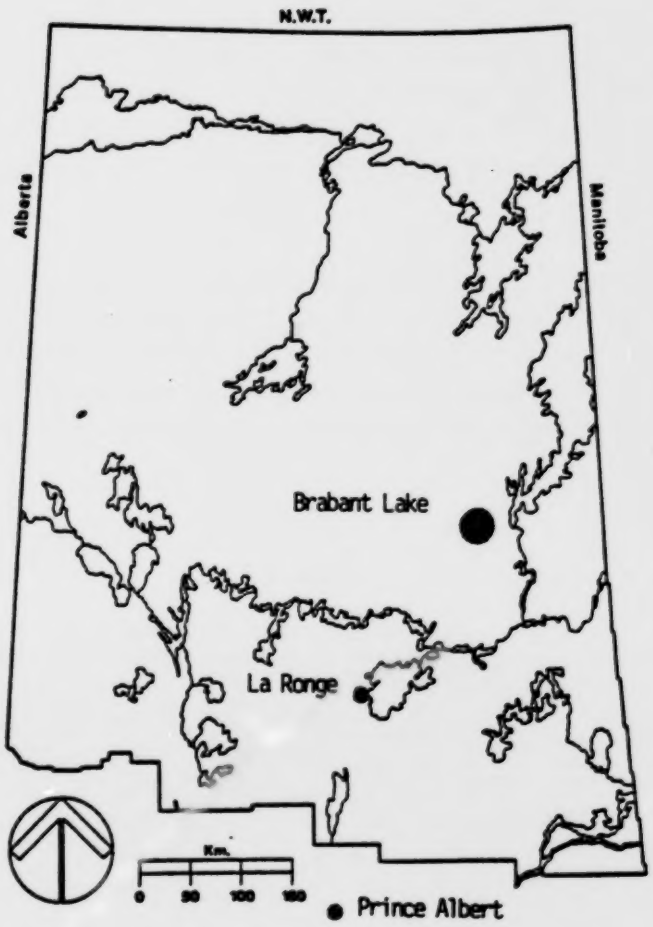
BRABANT LAKE SCHOOL

2.0 BRABANT LAKE SCHOOL ENERGY AUDIT

2.1 Background

Figure 2.1

Location of Brabant Lake



Brabant Lake School is located in Northern Saskatchewan at 56.2° N latitude, about 380 km north of Prince Albert. The community of Brabant Lake is classified as a remote community. At present, all electricity for the community is provided by a diesel-electric generating station operated in the community by Saskatchewan Power. The school also has a backup diesel-electric generator intended primarily to operate the heating systems in the school during times of power failure.

Most of the community residents heat their homes with wood. The school is the only source of running hot water and as a result many of the residents utilize the shower facilities. There are approximately 180 residents in the community and 60 children attending classes full time.

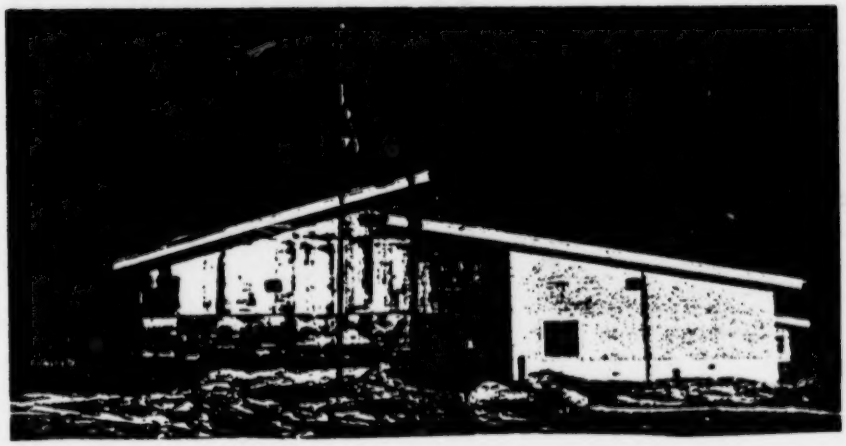
Data for this audit was collected during an on-site inspection conducted December 20, 1984. The outside air temperature at the time of the audit inspection was -38° C. Additional data was obtained from the Northern Lights school board, and Sask Power who carried out a limited inspection of the school facilities in August, 1984.

Figure 2.2

The Community of Brabant Lake

Figure 2.3

The Main Entrance To Brabant Lake School



2.2 School Characteristics

2.2.1 Energy Consumption

Figure 2.4

Annual Energy Consumption For Brabant Lake School (1982-83)

ENERGY TYPE	1982 CONSUMPTION	1982 COST($)	1983 CONSUMPTION	1983 COST($)
Electricity (kWh)	53,160	18,360	91,680	33,940
Fuel Oil (litres)	30,496	9,290	17,480	5,510
TOTAL	—	27,650	—	39,450

Notes: 1. 1982 Electrical costs were $0.345/kWh
Fuel oil costs were $0.309/l

2. 1983 Electrical costs were $0.37/kWh
Fuel oil costs were $0.315/l

3. The discrepancies in fuel oil and electrical consumption between 1982 and 1983 are discussed on page 37 and 40 of this document.

2.2.2 School Size

- Brabant Lake School has a heated area of 739 m^2 (8,583 sq. ft.) which cost, in 1983, \$53/m^2 to light and heat.
- The exterior wall area is 386 m^2 (4,151 sq. ft.) and is largely 2" x 6" wood frame construction.
- Window area is 2.16 m^2 (172 sq. ft) which is approximately 6% of the wall area. The door area is 19 m^2 (208 sq. ft.).
- On average, 45 to 60 students occupy the school during a regular school day.

2.2.3 Building Heat Loss

Figure 2.5 presents a breakdown of building energy loss of Brabant Lake School attributable to building envelope and ventilation losses. This data is based on an audit performed in August, 1984 by Saskatchewan Power Corporation. The actual fuel consumption figures are based on climate and fuel data for the period of July, 1983 to June, 1984. Based on Sask Power's calculations, ventilation and natural air leakage accounts for over 50% of the building heat loss. Traditionally, buildings of this vintage and type of construction should only have ventilation heat losses of 25% - 35%.

Figure 2.5

School Building Heat Loss For 1983*

HEAT LOSS TYPE	kWh	FUEL OIL** LITRES	FUEL OIL** COST($)	% OF TOTAL HEAT LOSS
Envelope Heat Loss	145,122	13,680	5,745	46
Ventilation & Infiltration Heat Loss	173,140	16,300	6,850	54
TOTAL HEAT LOSSES	318,262	29,980	12,595	100

* Calculation based on degree days for Prince Albert (6562°C degree days)
** Estimate for fuel oil based on 60% seasonal operating efficiency for forced air furnace

2.2.4 Operating Hours

Figure 2.6

Operating Hours For Brabant Lake School

	MON.	TUES.	WED.	THURS.	FRI.	SAT.	SUN.
8:00 a.m. to 5:00 p.m.	45 to 60 occupants					unoccupied	
6:00 p.m.	1 occupant until 10:00 p.m.					unoccupied	
7:00 p.m. to 10:00 p.m.	Community					unoccupied	

The entire school is at its maximum occupancy between 8:00 a.m. and 5.00 p.m. from Monday to Friday. The janitor cleans the classrooms 5 evenings a week from 6:00 p.m. to 10:00 p.m. The community uses the activity room and showers three evenings a week between 7:00 p.m. and 10:00 p.m.

All furnace thermostats are left at occupancy settings (15°C to 21°C) twenty-four hours per day.

The interior lights are usually shut off after hours. Staff, caretakers and community have been instructed to turn lights out upon leaving the building.

2.3 The On-Site Audit

2.3.1 Introduction

The on-site audit procedure involved 4 major tasks:

- An interview with the school principal
- An exterior inspection of the structure and its ventilation and combustion flues and vents
- A room by room walk-through inspection of the building
- A review and inspection of the mechanical systems and the operating controls. Including testing of the steady state operating efficiency of at least 1 furnace per mechanical room

Additional information was provided after the on-site audit by the school maintenance personnel.

2.3.2 Interview With The School Principal

The interview with the principal of the Brabant Lake School provided the audit team with information regarding building occupancy and use. The principal also noted some areas of concern:

- All thermostats in the school are covered by lock boxes only accessible by the principal. The principal maintained a 20 °C setting on all thermostats, but often received complaints that the kindergarten and senior classrooms (both on the north side of the school) were too cold.
- In the kindergarten, the room thermostat controls the heating for an adjacent room. Occupants of the adjacent room often complain of overheating while at the same time the kindergarten was considered to be too cool.

- The principal was unaware of the purpose of, or operating guidelines for three remote fan switches located in the school office. The switches were labeled "vent 2", "vent 3", and "vent 4".

- The principal also noted that there had been periodic furnace malfunctioning.

- The principal felt lighting levels were rather high in the hallways and classrooms.

In his discussion with the audit team, the principal was very agreeable to the introduction of basic conservation measures including night setback thermostats and lowering the temperature of the hot water heater.

2.3.3 Room By Room Audit Inspection

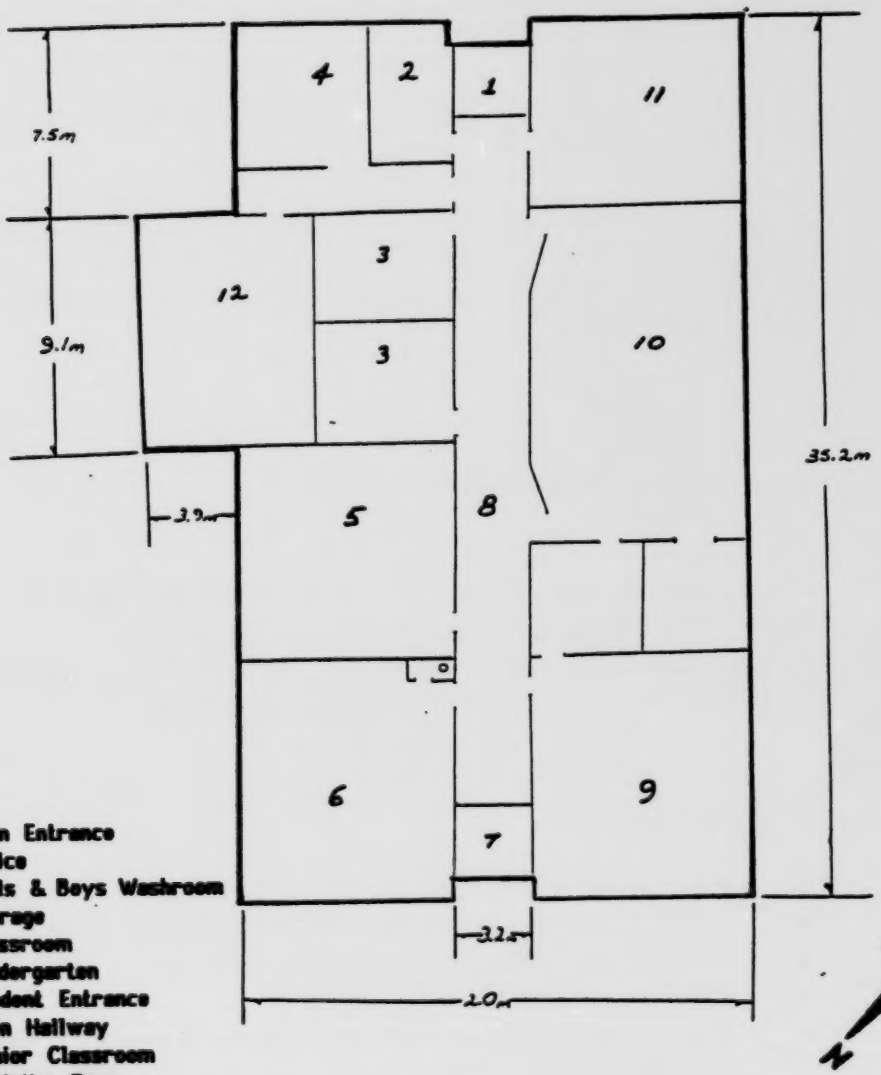
A summary of the findings of the walk-through audit is provided below. More detailed audit report forms for the Brabant Lake School can be found in Appendix A of this report. A floor plan of Brabant Lake School is provided in Figure 2.7 for reference.

(1) Main Entrance

- Main entrance only used by staff and visitors
- Bottom of front door needs weather stripping
- Recommend lighting be reduced from 320 Lux to 100 Lux
- One fixture with burnt out lamps
- Electric baseboard and hydronic heating in entrance. Given that secondary doors are always left open, the baseboards provide a very expensive form of heating, especially considering that there is heating this area supplied by hydronic heaters. Realistically, the heaters should be turned off, removed or the thermostat should be turned low enough that the heaters would only come on in emergency situations.

Figure 2.7

Floor Plan Of Brabant Lake School



KEY

1 Main Entrance
2 Office
3 Girls & Boys Washroom
4 Storage
5 Classroom
6 Kindergarten
7 Student Entrance
8 Main Hallway
9 Senior Classroom
10 Activity Room
11 Industrial Arts Room
12 Mechanical Room

(2) Office

- Lighting levels should be reduced from 950 Lux to 500 Lux
- The office has three on/off switches to control ventilation (labeled switch 2, 3 and 4). The principal is not sure what these switches are for.

(3) Boys and Girls Washrooms

- Lighting levels should be reduced from 320 lux to 250 lux
- Exhaust fans in both washrooms run continuously, energy could be saved by activating the fan only when lights are on or operating the fans on a manually controlled timer switch
- Temperature of hot water at the tap was 57°C

(4) Storage Room

- Lighting levels should be reduced from 250 lux to 100 lux

(5) Classroom

- Lighting levels should be reduced from 740 lux to 500 lux - students mentioned that lights were too bright
- Regular room occupants complain that room overheats. Thermostat for this room is in the adjacent kindergarten room where occupants feel the room is too cool.

(6) Kindergarten

- Occupants complain that room is often cool
- Lighting levels should be reduced from 740 lux to 500 lux
- Heating supply air grills and ducts in floor are partially blocked with dirt and garbage. Cleaning may increase amount of heat delivered to room.

(7) Student Entrance

- Weatherstripping needs replacement
- Like the main entrance this entrance has both electric baseboard heaters and hydronic heaters. Since secondary doors are left open and hydronic heating is already present, baseboard heaters are an expensive form of heat.
- Lighting levels should be reduced from 320 lux to 100 lux

(8) Main Hallway

- Heated with hydronic radiators
- Lighting levels adequate at 250 lux

(9) Senior Classroom

- Lighting levels should be reduced from 800 lux to 500 lux

(10) Activity Room

- When all lights are on lighting level is 860 lux. If half of lights turned off, checkerboard pattern of remaining on lights provide 460 Lux, very close to a recommended level of 500 lux. Recommended lighting patterns are noted in Appendix A.
- The outside air damper for the ventilation system for this room has been disconnected from its automatic motor control, leave-leav the damper fully open. (This damper is located in the mechanical room.) The net result of the open damper is that an unnecessary amount of cold outside air is drawn in to the building via the heating system for this room.

(11) Industrial Arts Room

- Lighting levels should be reduced from 800 lux to 500 lux
- Garage door to outside fits poorly, cover should be installed over vehicle exhaust hole in door

- School personnel keep lights off and temperature turned down when the room is not in use.

(12) Mechanical Room & Systems

- Building is heated by 4 oil-fired forced air furnaces (112,00 BTU/hr) and one oil fired hydronic heating system.

- The hydronic system provides heat for the crawlspace, hallway, building entrances and industrial arts room.

- An interview with maintenance personnel for the school revealed that general maintenance on mechanical equipment (eg. filters changed, fan belts checked, heat exchanger cleaned) occurred approximately once every year. The audit team recommends that filters could be checked and replaced on a more frequent basis to ensure optimum performance of the heating systems.

- The efficiency of one of the forced air furnaces was tested during the audit visit and found to be 81%. This is a relatively good operating level for this type of oil fired unit.

- In general, the condition of belts and filters on all the furnaces was found to be in good condition with one exception. The fan belt on furnace #3 was very loose. Furnace #3 serves the senior classroom. This loose belt may be the cause of complaints that the senior classroom was too cold.

- The damper control push rod on the automatic fresh air damper for the furnace #2 was disconnected, leaving the damper in a continuously open position. Furnace #2 provides heat for the activity room. The effect of the open damper is that an excessive amount of cold fresh air is drawn into the air distribution system on the furnace whenever the furnace fan is operating

- An inspection of the crawlspace found that the hydronic system was also used to provide heat to the crawlspace area, presumably to prevent freezing of pipes if the other furnaces in the building were inoperative. The audit team also found two electric baseboard heaters in the crawlspace. The heaters were turned on full and connected to a thermostat set at 25°C. These heaters were likely run continuously throughout the

year, for no apparent reason, and at a great cost to the school board. A subsequent interview with maintenance personnel revealed that the heaters were likely installed in the crawlspace two years ago to alleviate a moisture problem in the crawlspace. The crawlspace was found to be bone dry and at a temperature of 23°C.

2.4 Brabant Lake School Maintenance Practices and Evaluation

2.4.1 Interviews

An interview with the maintenance personnel provided the audit team with a general indication of the schedule followed for regular servicing of the school structure and mechanical systems. The maintenance man for Brabant Lake is located in Southend which is approximately 31 km north. Brabant Lake is also connected by road with LaRonge where the maintenance staff for the northern communities are located.

2.4.2 Maintenance Schedule

The annual maintenance schedule for Brabant School is:

- General Building: Replace broken windows
  Weatherstripping
  Repair any damage
- Replace Light Ballasts
- Blower Cleaning
- Change Oil Nozzles
- Clean Burner Motor
- Change Filters

The manufacturers recommended furnace maintenance practices are as follows:

- Inspect door gaskets and replace if leaking
- Replace the burner nozzle
- Replace air filter
- Replace oil filter

- Replace worn parts
- Adjust and service burner
- Oil motor bearings

There is a copy of the maintenance interview and the manufacturers recommended maintenance practice in Appendix B and C. As can be seen from the above, the recommended practices are generally being followed.

2.4.3 Audit Teams Observations

Exterior Doors

Needed weatherstripping. Garage door in industrial arts room has a hole (probably for venting car exhaust) that should have a removable cover.

Windows

The windows did not require any maintenance.

Mechanical

Furnace #2 Test:

Draft:	.06
CO2:	8.9%
Temperature:	240°C(470°F)
Efficiency:	81%
Filter:	Good
Belt:	Adequate

The analysis of this data was based on the tables in Appendix C
Using this information the furnace performance is rated as excellent and the burner performance as typical. To improve the burner performance the CO2 concentration of the flue gas should be 10 to 12 percent.

Ventilation

Although the blowers and filter are regularly maintained there did not appear to be any provisions for cleaning the duct system from observations of the supply air registers. Duct cleaning should be included as a regular maintenance procedure. Many of the supply air registers were clogged with a large variety of items and debris.

The system was last air balanced in 1980. Since there was a complaint of overheating and underheating in two classrooms, it is possible that imbalanced airflow and/or a clogged supply air duct may be the cause.

The fresh air supply for two of the ventilating systems should be checked. The outside air supply for the office has a manual damper. The damper is in the half open position. Also, the outside air supply for the activity room has an automatic damper. However, the push rod was disconnected from the modulating motor and the dampers were fully open. Considering the outside temperature and the relatively low occupancy rate, this is resulting in excessive ventilation.

Electrical

The lighting system was in good condition with very few lamps requiring replacement. There were, however, electrical resistance heaters in the main entrances and crawlspace. The design does not call for this as there are hydronic heaters located in each area.

2.4.4 Recommendations

In general the school appeared to be well cared for and operating as expected under the severe weather conditions. The recommendations for improved practices are as follows:

- Weatherstrip doors and caulk windows every September.
- Lower the temperature of the hot water heater to 50°C (122°F).
- Install high-velocity-low volume shower heads (see Appendix E)
- Ensure that fan belts, furnace filters, and oil filters are in good condition until the next inspection.
- Clean and maintain supply, return, and exhaust grills so that airflow is not hindered.
- Ensure that outside air dampers for all ventilating systems are set in the winter position. The outside air manual damper on furnace system #1 should be closed. The disconnected push rod on the outside air motorized damper control for furnace system #2 should be reconnected.
- Disconnect and remove all electrical resistance heaters.
- Raise control temperature of mixed air controllers. They are presently set at 13°C and should be increased to 20°C.
- Install a delayed action solenoid to control fuel oil supply.

2.5 Opportunities For Energy Conservation

2.5.1 Energy Conservation Through School Operations

Brabant Lake School is an appropriately designed school for the community it services. There are a number of areas where energy might be conserved by simply modifying the way the building is operated. This involves simply making the principal, teaching staff, caretakers and even students aware of the conservation opportunities available. These energy conserving operational practices should require very little time and relatively minimal training. The following suggestions are broken down into groups showing the people who will most likely be responsible or have input into the conserving measure:

Principal, Teachers, Caretakers, Students:

- Close the inside vestibule doors on the main entrances. This will substantially reduce infiltration of cold outside air and thereby reduce the amount of cold air the furnace has to warm up.

- Turn lights, fans, and taps off when they are not required. Any dripping hot water taps or noisy vibrating fans should be noted so that the maintenance staff can repair them. Burnt out or flickering light bulbs should be replaced immediately.

- Close the drapes after class as this will reduce heat loss through the windows during unoccupied hours. Also, on extremely cold days shutting the drapes should reduce the drafts caused by the windows.

Principal

- Ensure that during the winter the manually outside air damper is in a closed position. If odours develop the damper should be adjusted to an open position.

- Corridor and entrance temperatures are set at $15^{0}C$ and classroom temperatures are $20^{0}C$.

- Keep note of condition of weatherstripping, caulking, light bulbs, etc., so that the maintenance personnel can replace or repair them as the situation dictates.

Caretaker

- Vacuum furnace filters at least once a month.

- Check and vacuum the supply air registers to remove any items which have fallen in and may be hindering airflow.

2.5.2 Energy Conservation Through School Maintenance

The manufacturers recommended maintenance schedules should be adhered to with emphasis placed on the following which will reduce energy consumption:

- Turn back the setting on the hot water heater to 50°C (120°F).
- Regularly service the domestic hot water heater.
- Ensure fan belts are correctly adjusted on furnaces.
- Ensure air filters are clean.

The above not only helps to reduce consumption, but improves comfort and reduces wear on mechanical equipment. In addition to the above, the following will also conserve energy:

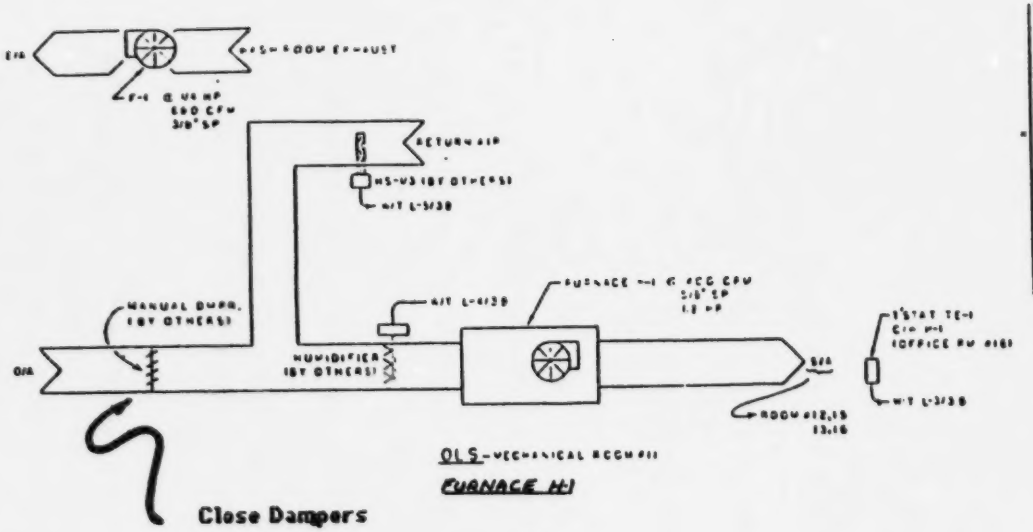
- Weatherstrip door and caulk windows.
- Have ducts cleaned on a regular basis.
- Clean supply, return and exhaust air registers and grills to improve airflow.
- Adjust manual outside air dampers for closure during winter.
- Raise temperature setting on mixed air controllers to 20°C (68°F) - presently set at 13°C (55°F). Refer to Figures 2.8 and 2.9.
- Air balance the ventilating systems.
- Rewire the washroom exhaust fan so it is turned on by a timer in each washroom.
- Install high-velocity-low volume shower heads to reduce hot water consumption.

The present control for the washroom exhaust fan is connected with the furnace blower on furnace system H-1 (Figure 2.8). When the furnace blower H-1 comes on so does the washroom exhaust fan. Thus the washroom air is being exhausted frequently but not necessarily when required, wasting heated air and electricity.

In addition, during regular servicing a delayed action solenoid valve could be installed on each of the forced air furnaces. The valve is installed downstream of the fuel supply pump, just before the burner of each furnace. Figure 2.10 presents the wiring diagram for the solenoid valve.

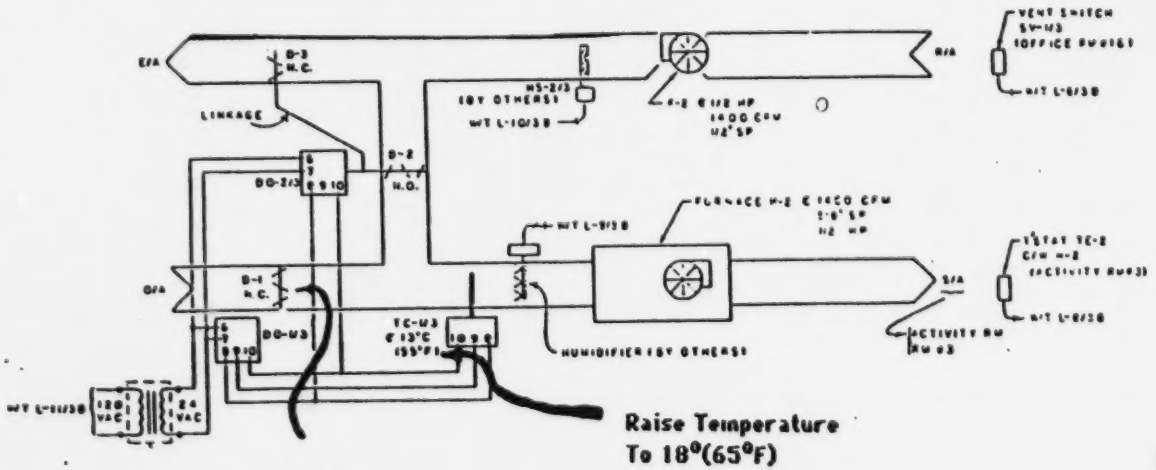
FIGURE 2.8

CONTROL DIAGRAMS FOR FURNACE H1 AND H2



OLS - MECHANICAL ROOM #11

FURNACE H-1



FURNACE H-2

BILL OF MATERIAL

D-1	1				REFER TO DAMPER SCHEDULE
D-2, 3	2				REFER TO DAMPER SCHEDULE

DESCRIPTION OF OPERATION

FURNACE H-1 (F-1)

THE UNIT IS LOCALLY OPERATED. WHEN THE BLOWER STARTS, EXHAUST FAN F-2 WILL START IN UNISON.

ROOM THERMOSTAT TE-1 OPERATES THE FURNACE BLOWER TO CONTROL ROOM TEMPERATURE AT SETPOINT. RETURN AIR DUCT HUMIDITY CONTROL HS-1/3 WILL OPERATE HUMIDIFIER TO CONTROL AT SETPOINT. HUMIDITY CONTROL IS DISABLED WHEN THE BLOWER IS OFF.

FURNACE H-2 (F-3, F-4)

PRESSURE SWITCH PS-1/3 WILL DETERMINE BLOWER DAY OPERATION CYCLE. RETURN FAN F-2 IS INTERLOCKED FOR UNISON OPERATION WITH THE BLOWER.

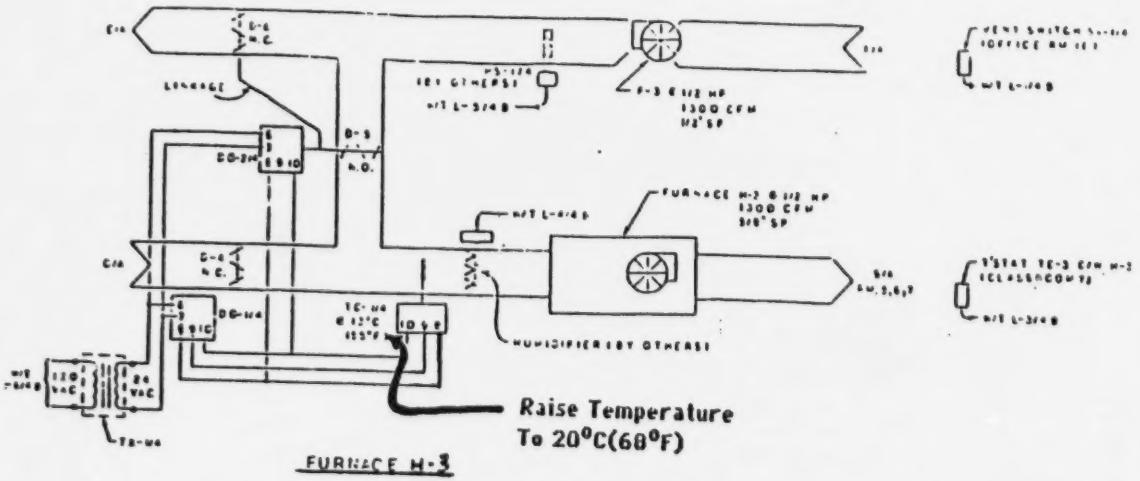
MIXED AIR CONTROLLER TC-1/3 WILL MODULATE THE MIXING DAMPERS TO CONTROL AT SETPOINT.

ROOM THERMOSTAT TE-2 OPERATES THE FURNACE BLOWER TO CONTROL ROOM TEMPERATURE AT SETPOINT. RETURN AIR DUCT HUMIDITY CONTROL HS-2/4 WILL OPERATE HUMIDIFIER TO CONTROL AT SETPOINT. HUMIDITY CONTROL IS DISABLED WHEN THE BLOWER IS OFF.

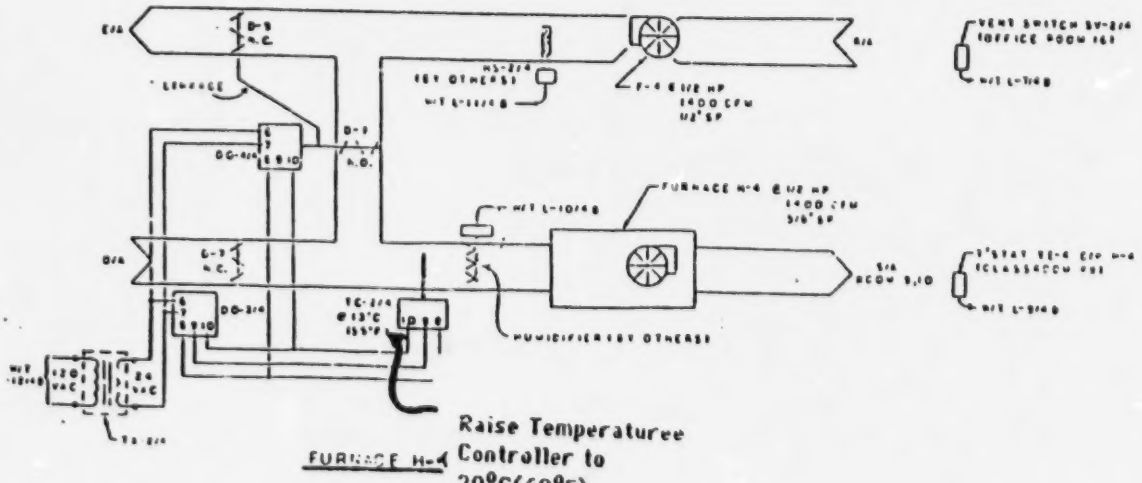
FURNACES H-1 AND H-2	H-3	
BRANT ELEMENTARY SCHOOL BRANT LAKE, SASK.	JOHNSON CONTROLS Systems & Service Division	24 OF 9

Figure 2.9

CONTROL DIAGRAMS FOR FURNACE H3 AND H4



FURNACE H-3



FURNACE H-4

BILL OF MATERIAL

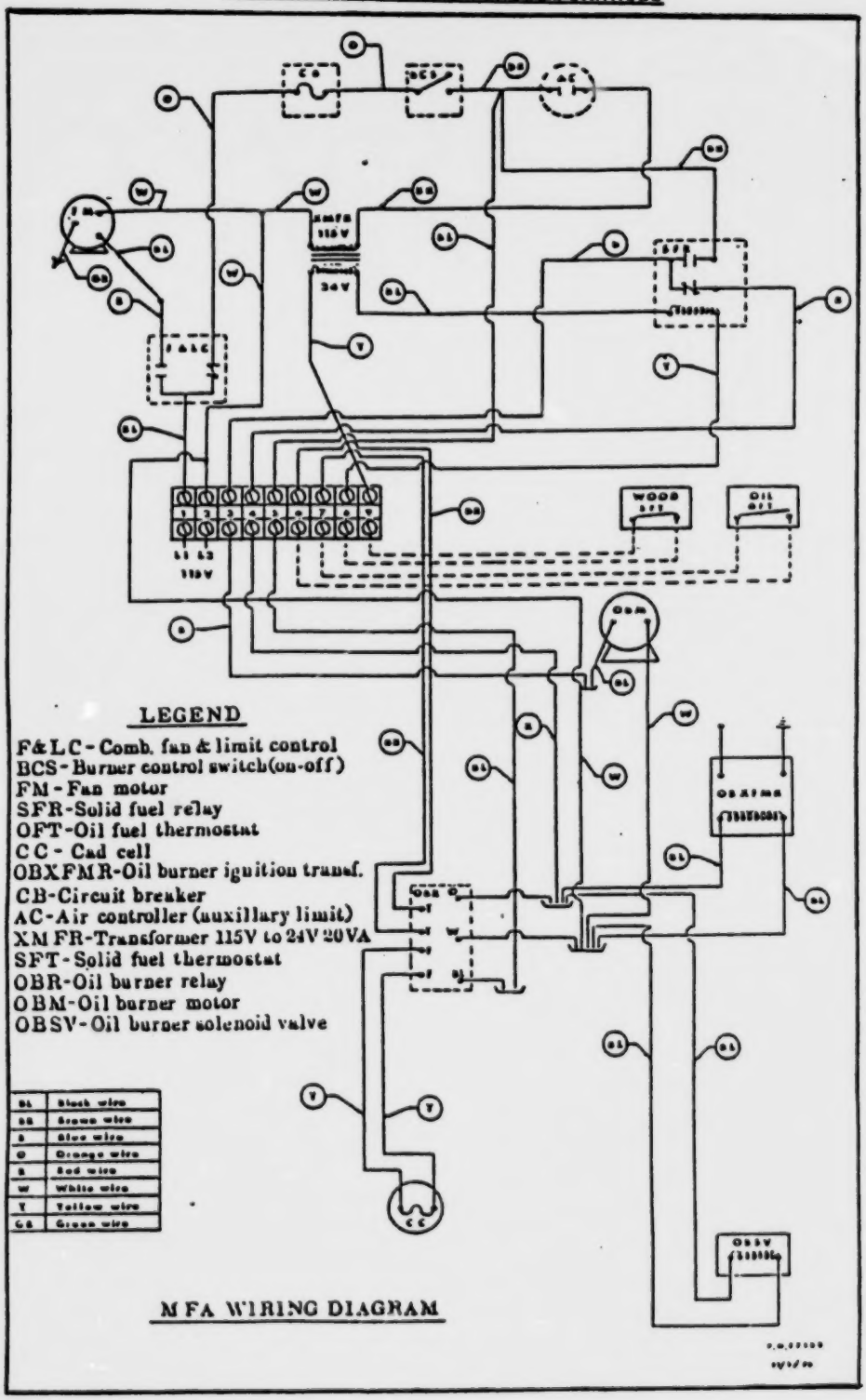
DESCRIPTION OF OPERATION

- 21 -

FURNACES H-3 AND H-4			

FIGURE 2.10

INSTALLING A DELAYED ACTION SOLENOID VALVE
IN THE BRABANT LAKE SCHOOL FURNACES


LEGEND
F&LC - Comb. fan & limit control
BCS - Burner control switch(on-off)
FM - Fan motor
SFR - Solid fuel relay
OFT - Oil fuel thermostat
CC - Cad cell
OBXFMR - Oil burner iguition transf.
CB - Circuit breaker
AC - Air controller (auxillary limit)
XM FR - Transformer 115V to 24V 20VA
SFT - Solid fuel thermostat
OBR - Oil burner relay
OBM - Oil burner motor
OBSV - Oil burner solenoid valve
Bk Black wire
Br Brown wire
B Blue wire
O Orange wire
R Red wire
W White wire
Y Yellow wire
Gn Green wire
MFA WIRING DIAGRAM

This is the manufacturers wiring diagram for the furnace. The delayed action solenoid valve replaces the oil burner solenoid valve or OBSV in the above diagram.

This device delays oil flow to the nozzle on start up, and stops flow instantly on shut down, reducing the introduction of unburned or partially burned oil into the combustion chamber. This will minimize soot and keep the furnace cleaner and maintain burning efficiency longer.

The furnaces at Brabant Lake School are new and have an energy efficient burner which incorporates a retention flame design.

2.6 Capital Investments That Result In Energy Conservation

2.6.1 General

There are a number of measures that will contribute to energy conservation for Brabant Lake School. These include:

- Night setback thermostats
- Improving the window systems
- Using a timer control on washroom exhaust fans
- Installing a delayed action solenoid
- Removing excess lights
- Using low-wattage fluorescent tubes

All of the following measures discussed have a simple payback of less then 5 years and most can be achieved by the school board maintenance personnel. Re-insulating the building shell was not considered a viable option since the school is still too new and has moderate levels of insulation already. That is, the high capital cost of adding more insulation cannot be justified by the moderate energy savings. A summary of the costs and savings of all measures outlined below is in Figure 2.16 at the end of this section.

2.6.2 Night Setback Thermostat

Night setback thermostats include a timer which allows for two temperature settings at different times and replaces the thermostats now installed. With a setback thermostat the temperature will automatically be turned down at the end of the day and will automatically warm up the building before students arrive in the

morning.

The activity room would remain at 20°C (68°F) until 10:00 p.m. in the evening during the week while the rest of the school could be setback at 5:00 p.m. On the weekend the school is unoccupied so all the thermostats may be setback. With setback thermostats the school could be kept at 15°C (60°F) for approximately 120 hours per week. The expected savings will be 3% for each degree the thermostat is turned back (ASHRAE FUNDAMENTALS 1981) OR $2,100.00 per year in fuel costs ($.42/litre).

Implementing this option is relatively easy as the school board maintenance personnel would be able to install the thermostats during their routine maintenance visits. The thermostats cost approximately $80.00 each. Brabant Lake School would require four, at a total cost of $320.00. The payback for this initiative would be about two months.

2.6.3 Installing Thermally Efficient Double Pane Windows

Replacing existing single pane plus storm windows with double panes plus storm will reduce the heat lost through the window area by increasing the R value. This will also reduce the chilly drafts that make the rooms uncomfortably cool at 20°C.

The windows in their present condition are responsible for about 10% of the total annual fuel consumed for heating. The value of this energy lost is approximately $1,200/year ($.42/litre). Upgrading the windows to double pane would have the effect of increasing the insulating value from RSI .27 (R 1.53) to RSI .59 (R 3.3) for each window. The fuel costs due to heat loss through the windows could be reduced to $550.00 per year. A savings of approximately $650.00 per year.

Unfortunately, the cost of triple glazed windows is about 50% more than double glazed which places the payback period for triple glazed beyond the 5 year criteria.

An additional benefit that is not included in this simple economic analysis is the benefit of using the windows for daylighting during the winter. The classrooms at Brabant Lake are using the drapes to

reduce the cold drafts from the windows. This shuts out daylight and sunshine making it necessary for all the lights to be on. The light levels for these classrooms are more than adequate with the drapes closed.
However, with the drapes open it is possible that the bank of lights by the window could be switched off resulting in significant electrical savings.

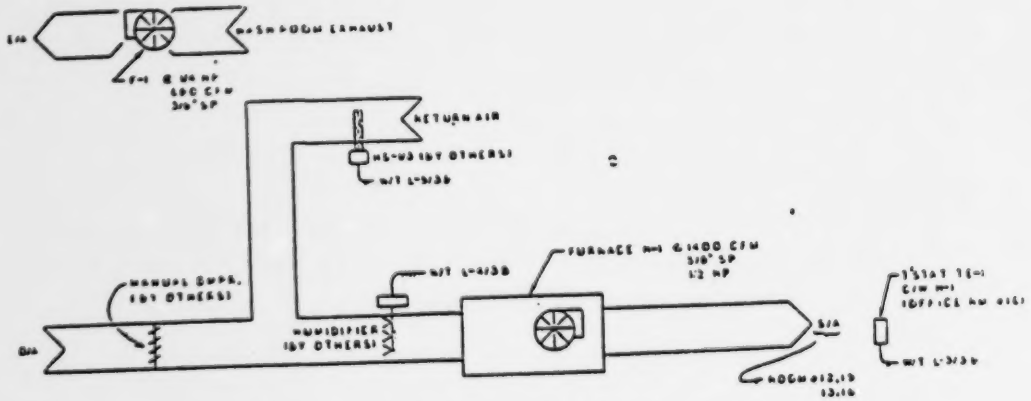
2.6.4 Using A Timer For Washroom Exhaust Fan Control

The present washroom exhaust fan system is controlled in conjunction with furnace #H-1. Furnace #H-1 heats the office, storage room and washrooms; the thermostat is in the office. The exhaust fan operates everytime the furnace comes on. As a result, a substantial amount of heated air (345/litres) is exhausted from the washrooms irrespective of actual washroom ventilation needs.

The description of operation as described in the mechanical drawings for the school is as follows: "The unit is locally operated. When the furnace blower starts exhaust fan F-1 will start in Unison".

FIGURE 2.11

CONTROL DIAGRAM FOR BATHROOM EXHAUST FANS
BRABANT LAKE SCHOOL



FURNACE H-1 CONTROLS - MECHANICAL ROOM #11

This system is not only wasting heated air but also electrical energy. Savings can result if a timer control is installed in each washroom that can be turned on for (a maximum of) 15 minutes when required. The cost of materials for timers and electrical wiring is approximately $240.00.

An accurate estimate of heat loss and potential savings of rewiring the exhaust fans is difficult because determining the hours of operation per day would require actual monitoring of the fan system. However, a general estimate can be made. If the fan operates for one hour it is exhausting heated air that has used approximately 2.2L of fuel oil to attain room temperature. If the fan runs 4 hours per day for the 300 days of the heating season, it is wasting 2,640L of fuel oil for $1,100.00 per year.

2.6.5 Installing A Delayed Action Solenoid Valve

A delayed action solenoid valve is installed between the burner nozzle and oil supply pump. On furnace start up it delays the "on" flow of oil to the nozzle for a few seconds allowing the combustion air fan to reach full speed and the oil pump to reach its full operating pressure. On shut down, the valve closes instantly, preventing additional oil from leaving the nozzle. In this way unburned or partially burned oil is prevented from entering the combustion chamber at the beginning and end of each heating cycle thus increasing efficiency.

This device extends the operating life of the nozzle by preventing clogging with unburned residues. Also the furnace will run cleanly with less excess combustion air and reduced amounts of soot which keeps the heat exchanger clean.

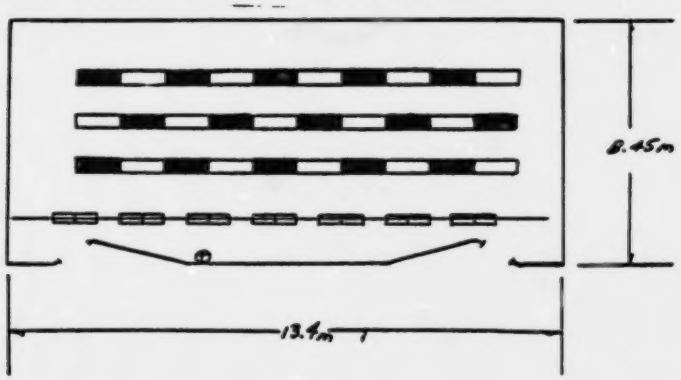
2.6.6 Delamping Excess Lights

In general, Brabant Lake School has more than adequate lighting levels for proper visual contrasts. Therefore, it is possible to achieve electrical savings by removing lamps and disconnecting ballast.

The lights are usually turned off at night after 10:00 p.m. and are turned on at 8:00 a.m. in the morning. On weekends all of the lights are left off. After 5:00 p.m. the only areas used in the school are the activity room and occasionally industrial arts room. Therefore, the classroom lights need not be turned on. The activity room has a very well designed light switching system. It is possible to turn half the lights off and still have the illumination evenly distributed throughout the room. The average light level using this configuration is 460 lux which is adequate for most activities. Figure 2.12 illustrates one of the lighting configurations possible.

Figure 2.12

BRABANT LAKE ACTIVITY ROOM:
LIGHTING PATTERN WITH HALF OF THE LIGHTS SWITCHED OFF



Key
- Lights Turned Off
- Lights Turned On
- Celestory Windows

The estimated electrical consumption due to the present lighting system is 36,200 kWh per year at $0.39/kWh represents a cost of $13,760.00 . A detailed room by room break down of energy use is provided in Figure 2.13 including estimates for hours and days of operation. Figure 2.14 presents estimated reductions in consumption that could be realized after excess lamps are removed. The delamping plan presented in Figure 2.15 would reduce total annual lighting electrical consumption to 23,144/kWh/year representing a cost of $8,800.00 per year. The savings that could be achieved over a period of one year would be 12,198/kWh representing a dollar savings of $4,960 per year.

The delamping plan presented above is only an example, it would be necessary to measure the light levels before and after lamp removal to ensure that there will be adequate light levels. This may require hiring a professional light maintenance contractor, which could cost up to $1,500 or more. To implement a delamping project is relatively straight forward and could be accomplished using the school board maintenance staff.

Conversations with lighting maintenance contractor Richard Parker of Luminaire Specialty Ltd., in Regina indicated that costs may indeed be minimized by having the principals or maintenance personnel read the light levels. He thought that the project could be accomplished by using the electrical plans to identify areas to measure light readings for the maintenance person. Then the plans and a light meter would be sent to the school so that the appropriate measurements may be taken. Once this is done the readings would then be analyzed and delamping action recommended.

2.6.7 Using Low-Wattage Fluorescents Tubes

There are fluorescent lamps available which have greater efficiencies. These lamps emit more lumens per watt than regular fluorescents lamps. A lower wattage is required for virtually the same light levels. By relamping with lower wattage fluorescents energy costs can be reduced by 14 percent with a light reduction of less than 10 percent.

If the entire Brabant School lighting system was converted to lower wattage tubes the lighting electrical consumption would be 32,230 kWh or $12,250 (at $.38/kWh). This would result in annual savings of $1,510.00.

The capital cost to replace 296 - 40 watt tubes with low-wattage would be $700.00 (not including shipping). A switch to high efficiency fluorescent tubes need not occur all at once. If regular tubes were replaced with low-wattage fluorescents as required by general maintenance, high initial capital costs could be avoided. This type of relamping program would be completed over time so that over two or three years most fluorescents in the school would be low-wattage.

Figure 2.13

ESTIMATED ELECTRICAL CONSUMPTION OF PRESENT LIGHTING SYSTEM

Location	#of Fixtures	#of Lamps per fixture	Wattage Per lamp (W)	Total Wattage including Ballast (W)	Operating Time Hrs/Day	Operating Time Days/Year	Annual Electrical Consumption kWh
Mainhallway	12	2	40(F)	1080	14	200	3024
Office	2	4	40(F)	360	14	200	1010
Storage	8	1	40(F)	360	4	200	288
	4	1	40(F)	200	2	200	80
Bathrooms	6	2	40(F)	540	14	200	1512
	2	1	150	300	14	200	840
Classrooms	65	2	40(F)	5850	10	200	11700
Kitchen	4	2	40(F)	360	4	200	288
Activity Rm.	30	2	40(F)	2700	14	200	7560
Industrial	21	2	40(F)	1890	2	200	760
Mechanical Rm.	7	1	150	1080	8	200	1680
Outdoor Lighting	4	1	150	600	12	200	1440
	10	1	250	2500	12	200	6000
Total							36,182 KWH/YR

1 "F" indicates Fluorescent Lighting.

FIGURE 2.14

ESTIMATED ELECTRICAL CONSUMPTION AND SAVINGS OF A REDUCED LIGHTING SYSTEM

Light Fixture Location	#of Fixtures	# of Lamps Per Fixture	Wattage[1] (W)	Total Wattage Including Ballast (W)	Operating Time (hr/day)	Operating Time (day/yr)	Annual Electrical Consumption (kWh)	Annual Electrical Savings (kWh)
Mainhallway	7	2	40(F)=	630	14	200	1764	1260
Office	2	2	40(F)=	180	14	200	504	506
Storage	8	1	40(F)=	360	4	200	288	—
	4	1	40(F)=	200	2	200	80	—
Bathrooms	4	2	40(F)=	360	14	200	1010	502
Classrooms	47	2	40(F)=	4230	10	200	8460	3240
Kitchen	4	2	40(F)=	360	4	200	288	—
Activity Rm.[2]	30	2	40(F)=	2700	7	200	3780	1890
	15	2	40(F)=	1350	7	200	1890	
Industrial	21	2	40(F)=	1890	2	200	760	—
Mechanical	7	1	40(F)=	1050	8	200	1680	—
Outdoor Lighting	4	1	40(F)=	600	12	200	1440	—
	2	1	40(F)=	500	12	200	1200	—
Total							23,144 kWH/Yr	

*Based on delamping plan presented in Figure 2.14, reduced electrical consumption only attributable to a reduction in the number of fixtures used.

1 "F" indicates Fluorescent

2 Based on 1/2 of activity room lights off 50% of regular operating time

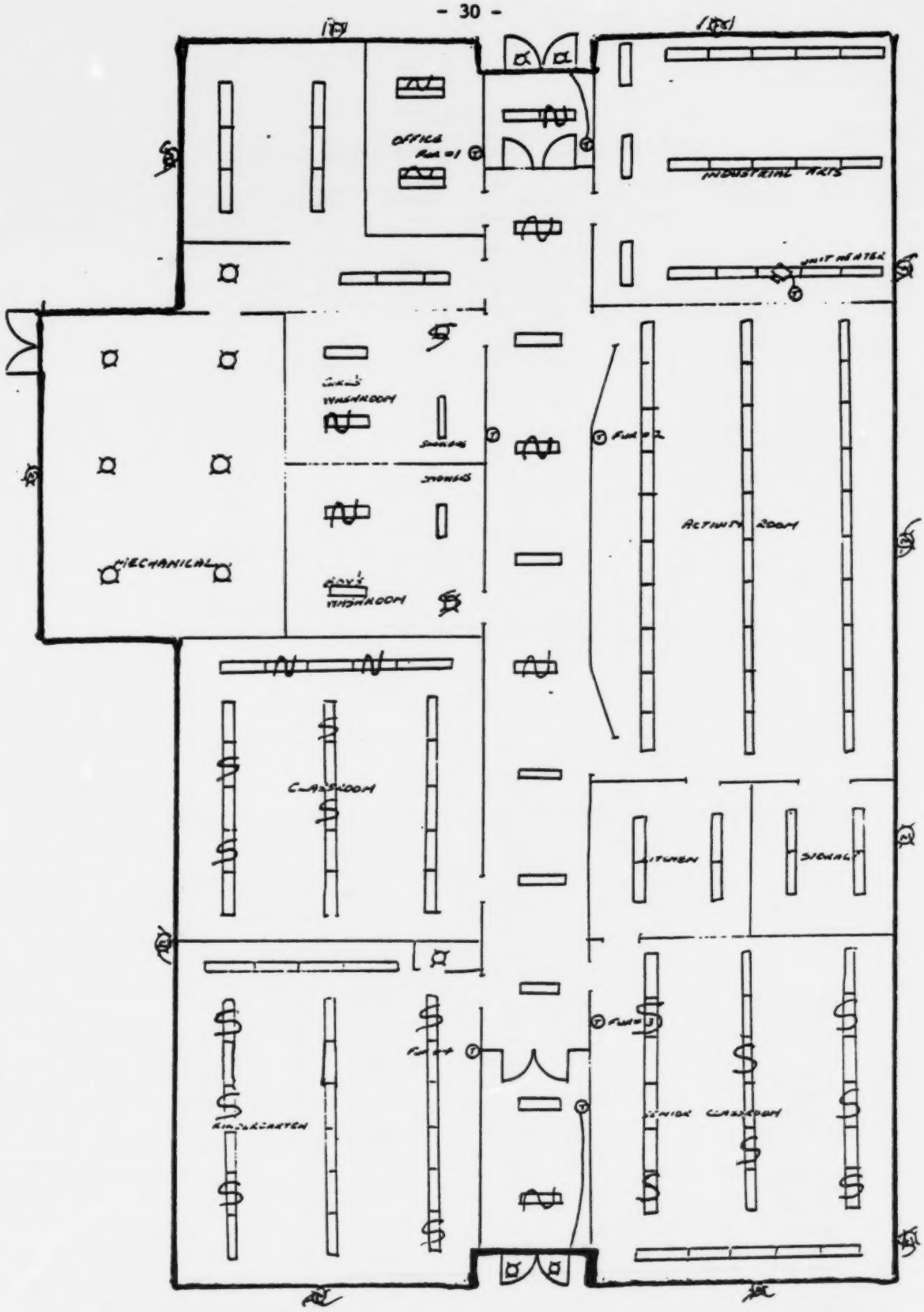


FIGURE 2.15

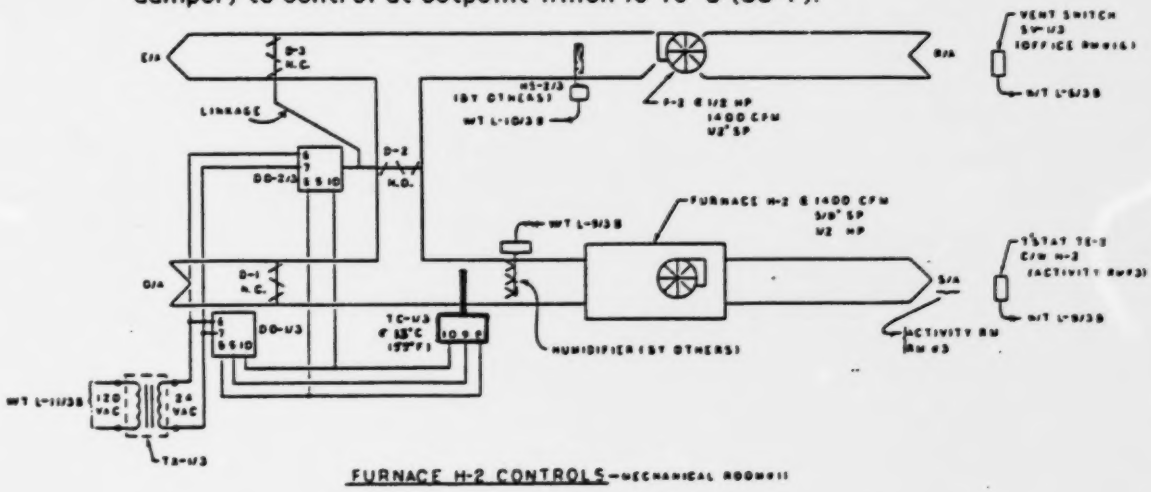
BRABANT LAKE SCHOOL WITH A REDUCED LIGHTING SYSTEM

One lighting maintenance contractor contacted by the audit team indicated that the standard low-wattage tubes seem to have a shorter life-span and may have problems with older ballasts. An investigation and comparison of the various brands of lower wattage bulbs would probably be worth while before establishing a purchasing policy.

There are also some fluorescent tubes on the market that claim to be low-wattage and long lasting (one brand name is Vita-Light). While these type of light tubes are 5-6 times more expensive than regular fluorescent tubes the manufacturer claims they will pay for themselves in 2.2 years (the bulbs are guaranteed for 2.5 years). Further investigation of this type of tube is recommended if a relamping program is adopted.

2.6.8 Increasing Control Temperature For The Mixed Air Controller

Presently, on furnaces H-2, and H-4 the mixed air controller modulates the mixing dampers (outside air damper and return air damper) to control at setpoint which is 13^0C (55^0F).



FURNACE H-2 CONTROLS—MECHANICAL ROOM #11

The warm room air (20^0C) is drawn back to the furnace and cooled down to 13^0C by letting cold outside air in. According to ASHRAE Fundamentals 1981 "These systems give good comfort control but waste energy. More recent designs allow a floating mixed air temperature based on zone loads or outside air temperatures.

Discussions with an engineer for Johnston Controls offered a simple improvement that entails raising the temperature of the controller to $20^{0}C$. This will effectively minimize cold air being introduced into the system. Leakage around the dampers and natural infiltration should supply adequate fresh air.

Figure 2.16

SUMMARY OF MEASURES THAT WILL CONTRIBUTE TO ENERGY CONSERVATION

Option	Annual Fuel Requirement (Litres)	Annual Fuel Costs ($.42/L)	Capital Cost of Option (Does Not Include Labour)	Lifecyle of Fuel Cost Over 15 Years	Net Savings Over Over 15 Years
No Retrofit	29,000	$12,200	Nil	$148,350	Nil
Night Setback Thermostat	24,000	$10,000	$ 320	$122,580	$25,770
Improving Windows	27,500	$11,550	$ 3,100	$140,450	$ 4,804
Timer Control For Washroom Exhaust Fans	26,360	$11,070	$ 240	$134,610	$13,500

Electrical	Annual Fuel Requirement KWH	Annual Fuel Cost ($.38/kwh)	Capital Cost	Lifecyle Cost Of Electricity Over 15 Years	Savings
No Energy Retrofit	91,680	$34,840	0	$423,665	0
Delamping	78,624	$29,880	$1,500	$363,350	$58,815
Relamping With Low-Wattage Tubes	87,728	$33,340	$700(initially) $5,600 (over 15 years)	$405,425	$12,640

Note: 1. Numbers May Not Add Due To Rounding
2. Savings are not additive. That is - as each measure is implemented the possible savings of the remaining measures decreases.

2.7 Energy Implementation Plan

2.7.1. Initiatives Involving No Capital Investment Resulting In Immediate Savings

General Maintenance:

- Increase temperature setting to 20°C (68°F) on mixed air controller for furnaces H2, H3, and H4.
- Clean and maintain supply air ducts.
- Lower temperature of hot water tank from 71°C to 50°C for a 30% savings in hot water heating costs. Savings could be as much as $300/year.
- Set outside air dampers in winter position (closed). This could save as much as 50% of the fuel bill attributed to ventilation losses. Savings could be as high as $400/year.

Operations - Principal, Teachers, Caretaker, and Students:

- Keep vestibule doors closed and save as much as 10% of the fuel bill attributed to ventilation losses this could be as high as $270/year.
- Turn lights, fans and taps off when they are not required.
- Close the drapes after class and on very cold days and save 7% to 14% of the heat loss due to the windows. The savings could be $75/year to $150/year.
- Vacuum furnace filters as dirty furnace filters lower the combustion efficiency significantly.

2.7.2 Initiatives Requiring Captial Investments

General Maintenance:

- Weatherstrip doors (including a weatherstrip kit for garage door) and caulk windows. The cost is approximately $175.00 a year but could save as much as 15% of the fuel bill attributed to ventilation losses or as much as $400/year.

- Install efficient showerheads that give a high-velocity-low volume flow of water. This will save hot water and therefore

energy. Manufacturers claim hot water costs can be reduced by 50%, which could be a $500/year savings. (See Appendix E)

- Have the ventilating system airbalanced once the ducts have been cleaned, as there have been complaints of inadequate heat in some rooms.

- Install a delayed action solenoid on each furnace burner. This will lower maintenance requirements and increase furnace efficiencies.

Energy Conserving Measures:

- Install night setback thermostats costing $320.00 and saving 17% of the annual heating bill or approximately $2,000.00 per year.
- Install timer control for washroom exhaust fan costing $240.00 and saving 9% of the annual heating bill or approximately $1,100.00 per year.
- Upgrade the windows costing $3,100.00 and saving 4% of the heating bill or approximately $500.00 per year.
- Remove excess light fixtures costing approximately $1,500.00 and saving14% of the electrical bill or $5,000.00 per year.
- Relamp with lower wattage tubes will costing $700.00 and saving 4% of the electrical bill or $1,500.00 per year.

2.7.3 Summary of Measures:

The savings resulting from the above recommendations are supported by economic calculations, wherever possible. However, some measures cannot be realistically calculated such as cleaning, and maintaining supply air ducts and regularly cleaning furnace filters. While accurate calculation of savings is not possible these types of initatives are equally important and if not attended to may contribute to significant losses.

All calculations of savings are based on 1982 consumption and on a fuel cost of $.42/L for fuel oil and $.38/kwh for electricity. Also savings are not additive, as the measures are implemented the percentage savings from unadopted recommendations decreases.

2.8 Implementation Timetable

When to initiate the above energy conserving implementations is a critical decision. Deciding not to implement any of the recommendations or even delaying the decision by half a heating season will result in a waste of energy and money.

The following checklist is a sequence for implementing energy conserving options at Brabant Lake. The first measures are the "no cost" recommendations which are simply related to building operation and maintenance. This is followed by low cost options which offer large savings and quick paybacks. While the final group includes the options requiring a greater capital investment.

Immediate

- Close vestibule doors for both entrances.
- Turn lights, fans, and taps off when not required.
- Close drapes after class.
- Ensure outside air dampers are in closed position.
- Set corridor and entrance temperatures at 15°C (60°F) Classrooms at 18°C to 20°C (68° - 70°F)
- Have the caretaker vacuum furnace filters once a month.
- Vacuum supply air registers.
- Turn temperature back to 50°C (122°F) on water heater.
- Check fan belts for correct tension.
- Check that furnace filters are clean.
- Adjust manual outside dampers to the close position for the winter.
- Connect the outside air damper push rod to the motorized control on heating system H-2.
- Increase temperature on mixed air controller from 13°C (55°F) to 20°C (68°F).
- Install a fuel line meter (to monitor monthly consumption).
- Disconnect all electrical resistance heaters.

Before The Next Heating Season

- Install night setback thermostats.
- Start regular servicing of domestic hot water heaters.
- Install efficient shower heads
- Rewire washroom exhaust fan to a manual timer control in each washroom.
- Install delayed action solenoid between oil burner and oil supply pump.
- Remove excess lights.
- Weatherstrip doors.
- Relamp with low wattage light tubes.
- Improve windows.

2.9 The Energy Budget

2.9.1 General

The true effect of an energy conservation program can only be measured if past and current fuel consumption is accurately documented. This section presents a historical perspective on the Brabant Lake School fuel use. Based on this historical data an energy budget of current energy consumption was developed. The budget provides a measuring stick for conservation initiatives and reflects energy use before any changes take place.

The final portions of this section present a method to monitor and document energy use so that the success of a conservation plan can be evaluated on an annual basis. This method allows an accurate comparison of fuel bills by adjusting portions of the energy use to actual climatic factors (degree days). The approach is relatively simple, and could be used by the school principal or some other member of the school board. This approach also forms a very good foundation for an energy incentive program.

2.9.2 Historical Energy Consumption

Figures 2.17and 2.18 presents electrical and fuel oil bills for the school from January 1982 to September 1984 inclusive. In addition Figure 2.19 presents a graphical presentation of monthly electrical use over the same period of time. Since only periodic oil bills are available a similar graphical representation of fuel bills is not possible.

The absence of a monthly fuel oil consumption record provided some limitations in developing an accurate energy budget. It is highly recommended that the school board invest in a fuel consumption meter that would allow regular monitoring of fuel oil use on a monthly basis.

One trend is worth noting in the tables and graphs presented in Figure 2.17 through 2.19. In the years 1982 to 1983 there was a 72% increase in electrical consumption and a corresponding drop in fuel oil consumption of 61% After careful investigation the audit team has concluded that this change in consumption occurred at about the same time electric heaters were installed in the crawlspace and entrances to the school. The increase in consumption is approximately equal to the electrical demand,and of operating the heaters, the electric heaters have been providing heat to the school that might otherwise be provided by the oil furnaces. In Brabant Lake, heating with electricity costs 14 times more than heating with oil. As a result, disconnecting the electric heaters in the school will save considerable energy and money. However, if the electric heaters are disconnected an increase in fuel oil consumption to pre-1983 levels should be expected.

An estimate of the actual annual energy that would be saved if these heaters were disconnected is provided below:

- The thermostat controlling the two crawlspace 1000w heaters at 25^{0}C, meaning that the heaters likely run 24 hours a day 365 days a year:

Annual Consumption 2 (kw) x 24(hr/day) x 365 (days/year)
= 17,520 kWh per year

@ $.38/kWh = $ 6,658 per year

- The four 750W electric heaters at the entrances likely run continuously throughout the 300 day heating season.

Annual Consumption 4 x 750(kw) x 24(hr/day) x 300(heating days)
= 21,600 kWh per year

@ $.38/kWh = $ 8,208 per year

- Disconnecting the heaters would result in an estimated savings of 39,120 kWh per year or $14,866. To provide the same amount of heat with fuel oil the cost would be $1000 to $1100.

FIGURE 2.17

ELECTRICAL BILLS FOR 1982, 1983, 1984. BRABANT LAKE SCHOOL

Month	1982 kWh	1982 Cost	1983 kWh	1983 Cost	1984 kWh	1984 Cost
JAN	4,380	$ 1,517.67	9,060	$3,139.29	9,360	$3,734.64
FEB	4,500	1,559.25	5,460	1,954.26	9,000	3,591.00
MAR	4,860	1,683.99	9,900	3,430.35	7,920	3,160.08
APR	4,560	1,580.04	8,460	2,931.39	7,380	2,944.62
MAY	4,380	1,517.67	8,340	2,889.81	6,540	2,609.46
JUN	2,880	997.92	8,820	3,056.13	6,480	2,585.52
JUL	EST		7,020	2,800.98	7,020	2,800.98
AUG	3,660	1,207.80	4,740	1,891.26	4,800	1,927.80
SEP	3,300	1,143.45	6,660	2,657.34	5,280	2,162.16
OCT	6,660	2,307.69	6,960	2,777.04		
NOV	6,180	2,141.37	7,860	3,136.14		
DEC	7,800	2,702.70	8,220	3,279.78		
TOTAL	53,160	$18,359.55	91,680	$33,943.77	63,780	$25,516.26

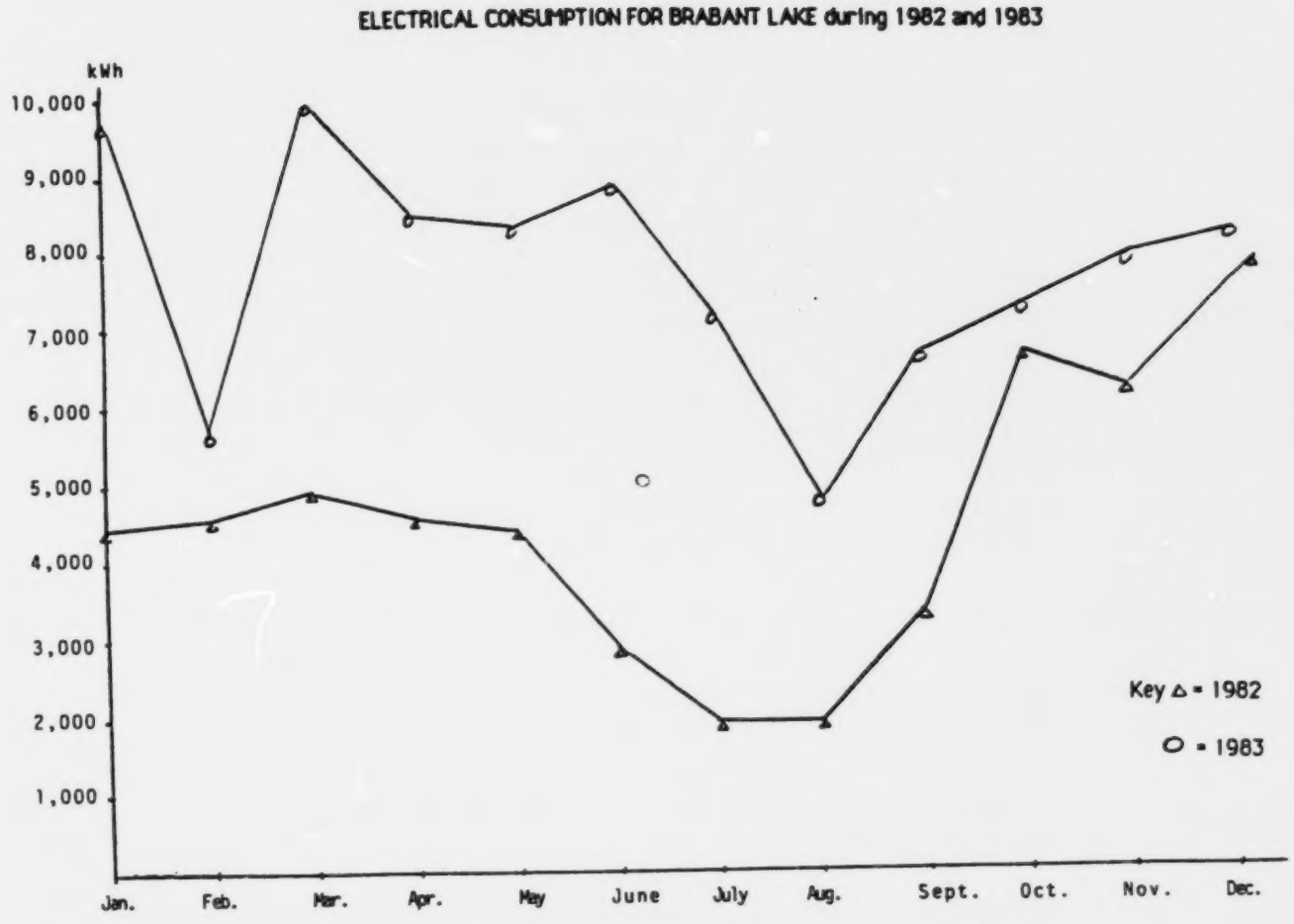
FIGURE 2.18

FUEL OIL BILLS FOR 1982, 1983, 1984. BRABANT LAKE SCHOOL

MONTH	1982 LITRES	1982 COST	1983 LITRES	1983 COST	1984 LITRES	1984 COST
JAN	8,683	2,296.04	5,683	1,658.74	5,697	1,854.84
FEB	--	--	--	--	--	--
MAR	9,024	2,755.96	4,567	1,474.59	3,583	1,166.73
APR						
MAY						
JUN						
JUL						
AUG						
SEP	1,667	552.41	630	207.21	1,800	595.10
OCT	5,455	1,807.88				
NOV	2,879	954.15				
DEC	2,788	924.03	6,600	2,170.73		
Total	30,496	$9,290.47	17,480	$5,511.27	11,080	$3,616.67

FIGURE 2.19

GRAPH OF ELECTRICAL USE



2.9.3 Monitoring The Fuel Consumption

It is critically important to monitor the energy conservation implementation program. By maintaining accurate records, the effectiveness of various actions can be demonstrated and then costs and cost savings may be determined. This information is essential to sustain personal interest and participation in the programs.

Monitoring fuel bills on a regular basis can also be a preventative method for saving energy. For example, the monthly electrical fuel oil bills were recorded for this school over the past three years. It was noticed that electrical consumption rose significantly in the fall of 1982 and maintained that high level. This resulted in the electrical consumption increasing by 72% from 1982 to 1983! In addition, the fuel oil consumption dropped by 61% in the same time span. One of the possible causes for this is likely the electric heaters installed in the crawlspace to dry up excess moisture caused by a broken circulating pump. At the time of the audit the crawlspace was a cozy 24^{0}C. Since the school is only visited by maintenance people once or twice a year, the heaters were undoubtedly forgotten. These heaters should be disconnected.

To effectively monitor the fuel oil consumption it will be necessary to install a fuel meter in the oil line then have the principal record the fuel consumption on a monthly basis. This, as well as electrical consumption, should be kept track of on an on-going chart at the school and at the school board office for maintenance staff. It may also be of interest to mark on the charts specific dates of implementations.

Calculating savings will require the principal to make some computations to obtain the theoretical fuel consumption based on the outside temperature. This value is compared with the actual consumption for that month as monitored by the fuel line meter.

The first computation is outlined in Figure 2.20 where the theoretical monthly consumption is calculated. The theoretical consumption is obtained by multiplying actual degree days by a factor which is derived from the building heat loss characteristics, furnace efficiency and heating value of the fuel.

Figure 2.21 is a sample chart for recording actual fuel oil consumption and comparing actual consumption with theoretical consumption. Subtracting the actual consumption from the theoretical consumption will result in the litres of fuel saved. Dividing litres saved by the theoretical consumption will give a percentage savings.

The following steps are all that is necessary to calculate savings:

- Phone Environment Canada Climatic Services Department to obtain the actual degree days for the month. Record degree days on the electric and fuel oil charts (see Figure 2.21 and 2.23)

- Calculate the theoretical fuel consumption by multiplying degree days by the constant k (see Figure 2.20). The constant k is unique for each building and reflects heat loss characteristics and furnace efficiencies. Record theoretical fuel consumption on the chart (Figure 2.21)

- Record actual fuel consumption from fuel line meter on the chart (Figure 2.21)

- Savings is obtained by subtracting the actual fuel consumption from the theoretical fuel consumption A positive number indicates a fuel savings. A large negative number (more than 10% increase) should be cause for evaluating the energy system to find the reason for the increase. Some possible reasons for an increase are: fuel line leaks, dirty furnace filters, dramatic change in building use.

FIGURE 2.20

CALCULATING MONTHLY THEORETICAL CONSUMPTION OR HEATING LOAD - BRABANT LAKE

1. Month:_____

2. Degree Days For Month:_____
(from Environment Canada Climatic Services)

3.[1] Oil Furnace:

_____Degree Days x 3.0 L/Degree Day_____Litres

The Theoretical Consumption=_____Litres
Or_____Litres ÷ 4.5 Litre/Gal =_____Gallons

Note: 1. The constant 3.0 is derived from the heat loss characteristics of the school, the estimated seasonal efficiency of the heating system and and the heating value of the fuel oil.

FIGURE 2.21

FUEL OIL ENERGY MONITORING CHART

SCHOOL:
YEAR:

Month	Normal Heating[1] Degree Days °C	Estimated Fuel[2] Consumption (Litres)	Actual Heating[3] Degree Days °C	Theoretical[4] Fuel Consumption (Litres)	Actual Fuel[5] Consumption (Litres)	Savings[6] (Litres)
JAN	1218.5	3660				
FEB	974.5	2920				
MAR	878.4	2640				
APR	482.1	1450				
MAY	250.4	750				
JUN	110.9	330				
JUL	48.0	140				
AUG	84.0	250				
SEP	244.1	730				
OCT	443.0	1330				
NOV	756.7	2270				
DEC	1068.7	3210				
TOTAL	6559.3	19,680				

1. Normal Heating Degree Days are thirty year averages from Environment Canada Climatic Services.
2. Estimated fuel consumption is derived by multiplying Degree Days by 3.0 L/DD which is an estimated constant based on heat loss characteristics of the schools seasonal efficiency of the heating system and the heating value of the fuel
3. Actual heating degree days from Uranium City Climatic Service.
4. Theoretical fuel consumption is obtained by multiplying: (Actual Heating Degree Days x 3.0 L/Degree Day)
5. Actual fuel consumption is read from the fuel oil line meter.
6. Savings is calculated by: (Theoretical consumption - Actual consumption) a positive answer is the litres saved.

2.9.4 Monitoring Electrical Consumption

The largest portion of the electrical bill is attributed to the lighting load. The amount of time the lights are on is fairly consistent throughout the school year. The remaining portion of the electrical bill is made up of electrical requirements of the fans and pumps necessary for heating and ventilating. This load fluctuates with the heating requirement of the building and therefore the outside temperature. So as temperatures drop the electrical load will increase.

An estimate of the base electrical consumption for the shcool requires an estimate of the hours of lighting operation. Also an estimate of the eletrical load due to the fans and pumps used by the heating system. This load fluctuates with the heating demand.

For this reason the base electrical consumption calculation is divided into two parts:

- The first is to estimate the hours lights were actually on for the billing period. Then multiply hours of operation by 13.3 kW/hour.
- The second is to estimate the consumption due to the heating requirement by multiplying degree days by 1.4 kWh/DD.

Using the sample form in Figure 2.22 an approximate electrical consumption can be calculated based on the schools present characteristics. If any energy conservation mearsures are implemented the actual consumption should be less than the estimated. The difference between the two numbers will be the savings. This analysis can be charted on the sample chart in Figure 2.23 so that the consumption and savings are monitored.

The following steps outline the steps for calculating electrical savings:

- Step 1 is shown in Figure 2.22 and is simply multiplying-actual Degree Days for the month by 1.4 kWH/Degree Days to find the electricity used by oil pumps and furnace fans.

- Step 2 is also shown in Figure 2.22 and is the calculation for the number of hours the lights were operated for the month and the electricity consumed. This is obtaind by multiplying operating hours/month by 13.3 kWh/hour.

- Step 3 is to add steps 1 and 2 to obtain the total estimated consumption based on previous electrical consumption.

- The final steps are performed on the sample chart shown in the Figure 2.23 where actual heating degree days for the month, operating hours/month and theoretical consumption can each be entered in the appropriate columns.

- Then actual consumption may be read from the meter and entered onto the chart.

- Savings is calculated by subtracting actual consumption from theoretical.

FIGURE 2.22

ESTIMATING ELECTRICAL CONSUMPTION
FOR BRABANT LAKE

Billing Period:_____

School:_____

Step I Estimate Due To Fans and Pumps

1. Degree Days_____
(from Environment Canada Climatic Services)
2.[1] Electricity Used:

_____Degree Days x 1.4 kWh/Degree Days=_____kWh

Step II Estimate Due To Lighting

1. Lights on for _____hours/per day
Lights used for_____days during billing period

Hours lights were on during billing period:

_____hours/day x_____days/billing period =_____hrs/billing period

2.[2] Electricity used:

_____hours/billing period x 13.3 kWh/hour=_____kWh

Step III Total Estimate of Electrical Consumption

1. Electricity used:

_____kWh(fans&pumps) +_____kWh(lights)=_____kWh

Notes:
1. The constant 1.4 kWh/Degree Day was derived based on the fuel use characteristics of the furnaces.
2. The constant 13.3 kWh/hour is an estimate of the average electrical consumption of the lights.

FIGURE 2.23

ELECTRICAL CONSUMPTION MONITORING CHART FOR BRABANT LAKE SCHOOL

Month	Base Estimate kWh	Actual Heating Degree Days	Hours Lights On	Estimated Consumption	Actual Consumption kWh	Savings kWh	Remarks
January	5,700						
February	5,350						
March	5,220						
April	4,670						
May	4,340						
June	2,820						
July	1,400						
August	1,450						
September	2,940						
October	4,610						
November	5,050						
December	5,490						

1. Base estimate is for comparison only do not use for calculating savings.
2. Actual heating degree days may be obtained from Uranium City Climatic Services Office.
3. Hours/Lights on - Is the number of hours the majority of the lights are on per billing period.
4. Estimated consumption is obtained from the following calculations which is (1.4 kWh /degree day X Actual degree day) + (13.3 kWh/hour X lights on).
5. Actual consumption from meter reading.
6. Savings is calculated by: Estimated consumption - Actual consumption) A positive answer is the kWh savings.
7. Remarks should record the dates of any energy conserving implementations. Also any comments regarding actual consumption or savings.

2.10. The Budget

Figure 2.24 presents an energy budget developed by the audit team for the Brabant Lake School. The budget represents energy consumption at the school before any conservation initiatives are taken. Based on the budget goals can be set. Depending on the conservation initiatives adopted a good general goal for the first year of a conservation program is 15 - 30%.

Energy consumed in future years can be measured against the energy budget and the actual percentage savings on a yearly bases can be calculated. The method presented in the previous pages allows for accurate comparison of year to year fuel bills by adjusting consumption figures to take into account climatic variations (eg. unusually warm or mild winter months).

FIGURE 2.24

ESTIMATED ENERGY CONSUMPTION AND COSTS WITHOUT IMPLEMENTING ANY OF THE CONSERVATION MEASURES

	Estimated Fuel Consumption (Litres)	Estimated Cost ($0.458/L)	Estimated Electrical Consumption (kWh)	Estimated Cost ($0.38/kWh)
JAN	3,660	$ 1,680	5,700	$ 2,170
FEB	2,920	$ 1,340	5,350	$ 2,030
MAR	2,640	$ 1,210	5,220	$ 1,980
APR	1,450	$ 660	4,670	$ 1,770
MAY	750	$ 340	4,340	$ 1,650
JUN	330	$ 150	2,820	$ 1,070
JUL	140	$ 60	1,400	$ 530
AUG	250	$ 110	1,450	$ 550
SEP	730	$ 330	2,940	$ 1,120
OCT	1,330	$ 610	4,610	$ 1,750
NOV	2,270	$ 1,040	5,050	$ 1,920
DEC	3,210	$ 1,470	5,490	$ 2,090
TOTAL	19,680	$ 9,000	49,040	$18,630

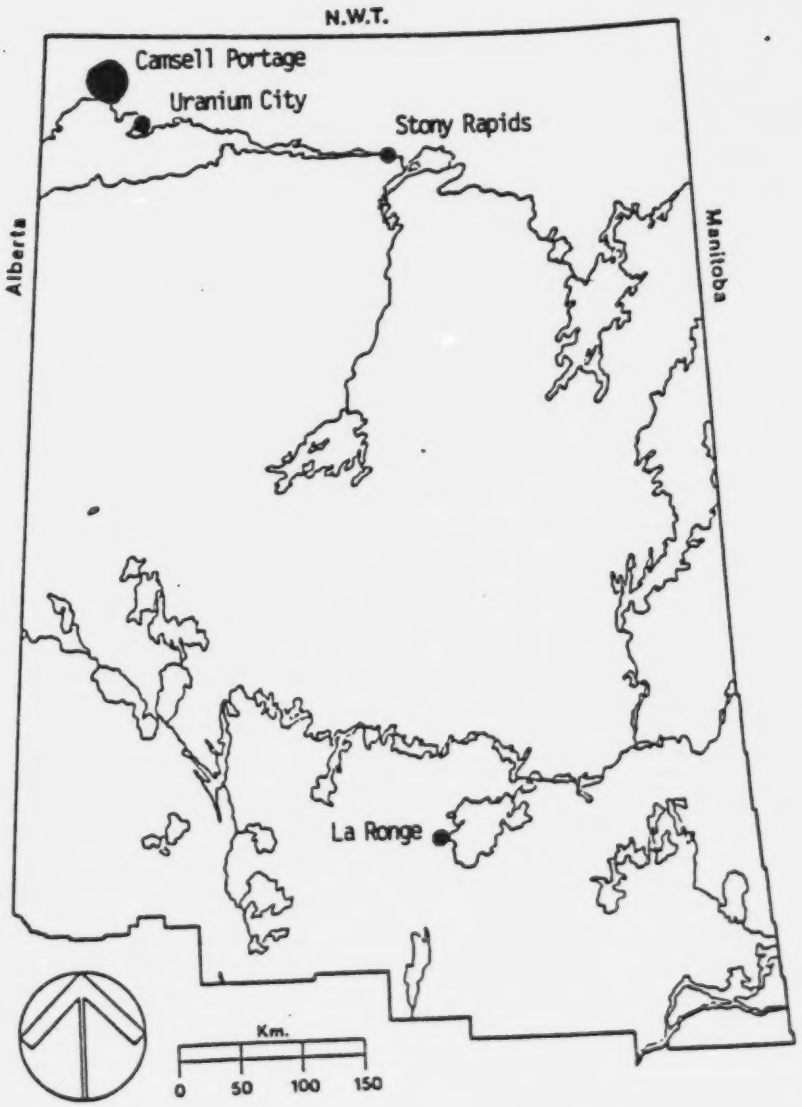
CAMSELL PORTAGE SCHOOL

Camsell Portage School Energy Audit

3.1 Background

FIGURE 3.1

LOCATION OF CAMSELL PORTAGE



3.1 Background Continued

Camsell Portage is located in Northern Saskatchewan at 59.6 N latitude, approximately 35 km NW of Uranium City. The community of Camsell Portage is classified as a remote community and is only readily accessible by air. All electricity in the community is provided by a diesel electric generator operated by Saskatchewan Power. The school does not have a source of backup power.

The majority of residents heat their homes with wood or a wood/oil combination stove. The school is heated with fuel oil brought in by barge during the summer months. The school is the only source of running hot water in the community and as a result, the entire community makes use of the shower facilities in the school. There are approximately sixty residents in the community. There are eleven students attending the school.

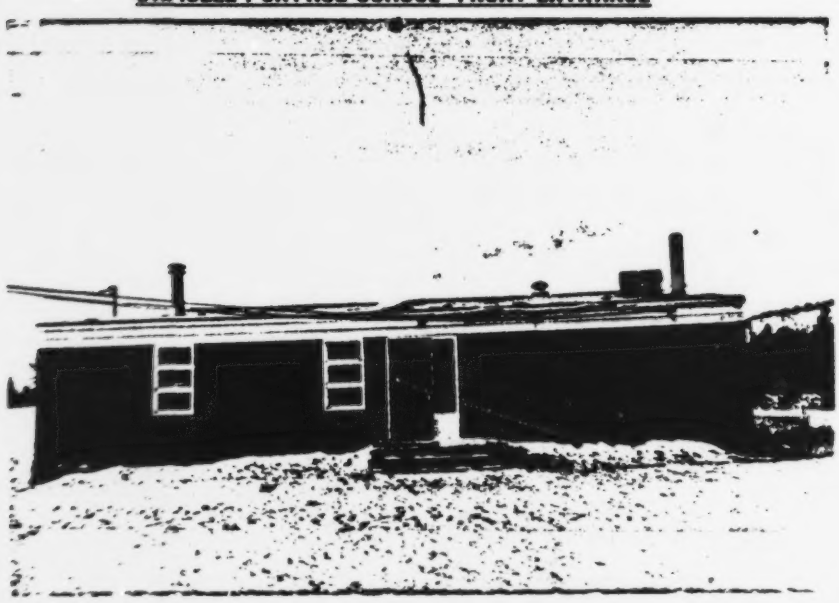
Data for this audit was collected during an on-site inspection conducted on December 19, 1984. The outside temperature at the time of the audit was -40^{0}C. Additional information regarding the school was also provided by the Northern Lights School Board and Saskatchewan Power who carried out a limited energy audit in August 1984.

Degree days for the Camsell Portage area as measured in Uranium City is 8,210^{0}C days.

The school is a two section pre-built structure resting on a pile system.

FIGURE 3.2

CAMSELL PORTAGE SCHOOL FRONT ENTRANCE



3.2 School Characteristics

3.2.1 Actual Energy Consumption for 1982 and 1983

The actual energy consumption for the years 1982 and 1983 is shown in figure 3.3 This information was obtained by the audit team from the electrical and fuel oil bills on file at the Northern Lights School Board office.

FIGURE 3.3

ANNUAL ENERGY CONSUMPTION CAMSELL PORTAGE SCHOOL

Energy Type	1982 Consumption	1982 Cost	1983 Consumption	1983 Cost
Electricity (kWh)	16,307	$ 5,650	13,325	$4,838
Fuel Oil (litres)	9,923	$ 4,905	9,317	$4,563
Total		$10,555		$9,401

Notes: 1. Costs have been rounded to the nearest dollar.
2. 1982 Electrical costs were $0.347/kWh
Fuel oil costs were $0.494/l
3. 1983 Electrical costs were $0.36/kWh
Fuel oil costs were $0.490/l

3.2.2 School Size

Camsell Portage has a heated area of 192 m^2 (2,064 sq. ft.). This reflects a cost of approximately \$49/m^2 to light and heat.

The exterior wall area is 119 m^2 (1,282 sq. ft.) and is of 2" x 4" wood frame construction. The window area is 16 m^2 (174 sq. ft.) or 13% of the wall area.

3.2.3 Estimated Building Heat Loss

Figure 3.4 presents a breakdown of estimated building energy loss from Camsell Portage school attributable to building envelope and ventilation losses.

The estimated fuel consumption figures were derived from climatic and fuel data for the period of July 1983 to June 1984. As can be seen from Figure 3.4, the estimated ventilation and natural air-leakage accounts for 55% of total heat losses. Given the age and condition of the school this percentage of heat loss through ventilation can be expected.

FIGURE 3.4

ESTIMATED SCHOOL BUILDING HEAT LOSSES FOR JULY 1983 TO JULY 1984*

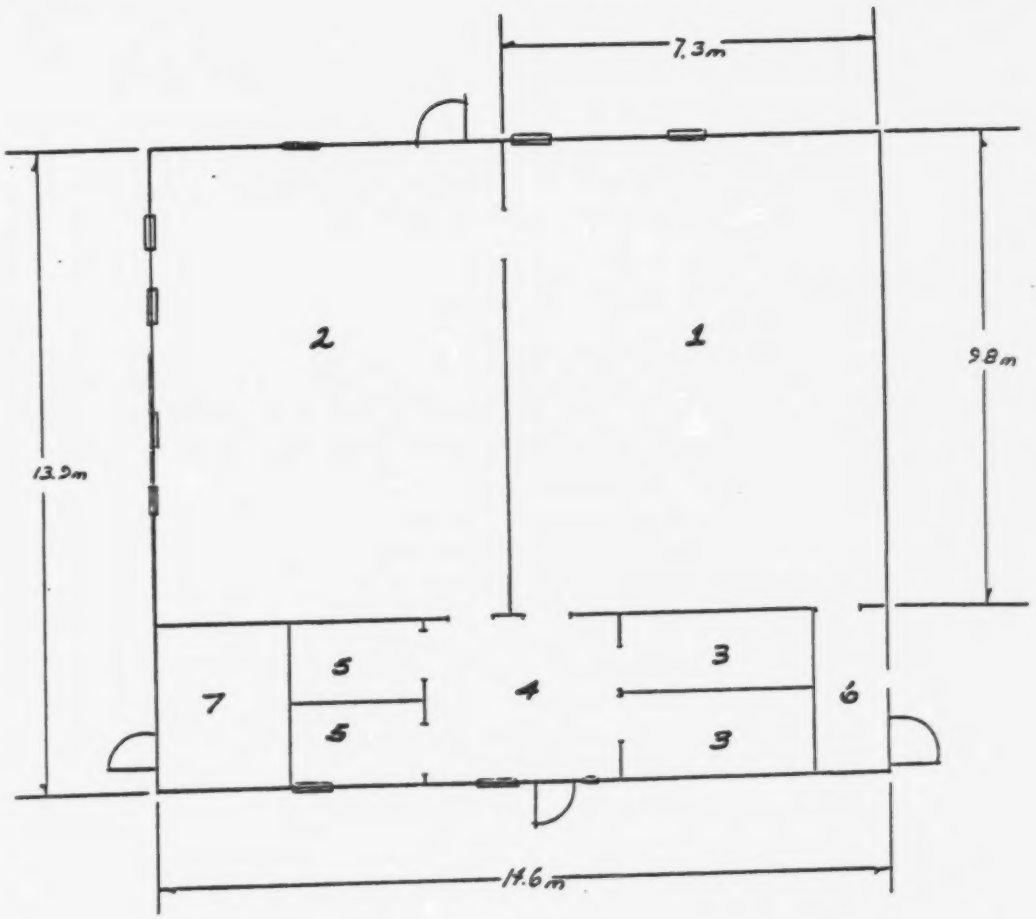
Heat Loss Type	kWh	Fuel Oil** Litres	Cost (\$0.49)	% of Total Heat Loss (%)
Envelope Heat Loss	47,800	4,500	2,200.	45
Ventilation + Infiltration Heat Loss	57,500	5,400	2,600	55
TOTAL HEAT LOSS	105,300	9,900	\$4,800.	100

* Calculation based on degree days for Uranium City (8,210 °C).

** Estimate for fuel oil based on 60% seasonal operating efficiency for forced air furnaces are calculated using fuel costs for the period of 1983 and 1984.

FIGURE 5

FLOOR PLAN OF CAMSELL PORTAGE SCHOOL



KEY

1. North Classroom
2. South Classroom
3. Washrooms
4. Main Entrance Vestibule
5. Shower and Storage Room
6. North Mechanical Room
7. South Mechanical Room

3.3 The On-Site Audit

3.3.1 Introduction

The on-site audit procedure involved four major tasks:

- An interview with the school principal.
- An exterior inspection of the structure and its combustion flues and vents.
- A room by room walk-through inspection of the building.
- A review and inspection of the mechanical systems and the the operating controls including the testing of the steady state operating efficiency of one furnace.

3.3.2 Interview With School Principal

The interview with the principal of the Camsell Portage school provided the audit team with information regarding building occupancy and use. In the interview the following characteristics of the school building were noted.

- Generally the classrooms maintained the appropriate thermostat setting.
- The more recently installed southern classroom is generally more comfortable in terms of warmth and absence of drafts compared to the older north classroom. As a result the southern classroom is used on a daily basis for instruction while the north classroom is used only occasionally.
- Each classroom has its own furnace and furnace room. The principal noted that the heat exchanger in the north furnace room located in the mechanical room has been leaking but was recently repaired by the school board maintenance personnel. He expects the furnace will be replaced at the end of the heating season.

- There is a ventilation fan in the ceiling of the north classroom, but there has never been a reason to operate it during the winter months.

3.3.3 Room By Room Audit Inspection

A summary of the findings of the walk-through audit is provided below. More detailed audit report forms of the Camsell Portage School can be found in Appendix A of this report. A floor plan of the school is also provided in Figure 3.5.

(1) North Classroom

- Some of the windows are in poor condition - caulking is dried and cracked and one window is broken and covered with plywood. All of the windows are single pane.

- Six of the fluorescent fixtures out of 14 fixtures in the room have burnt out tubes.

- The average lighting level in the room was found to be 300 lux which is well below the recommended level of 500 lux (See Appendix C for recommended illumance.)

- The exhaust fan in the ceiling is never used. Note: A switch for the fan is located below the chalkboard and well within reach of students.

(2) South Classroom

- One of the windows is single pane, poorly caulked and is quite leaky around the frame. The three other windows are double pane with a 3/4" airspace.

- The lighting level for the room was measured at 640 lux, above the recommended level of 500 lux.

(3) Washrooms

- The lights are turned off when the room is not in use.
- The exhaust fans were not operational.
- The temperature of the hot water at the tap was 46^{0}C.

(4) Main Entrance Vestibule

- Windows are all single pane, poorly caulked and leaky around the frame.
- Door needs weather stripping.
- The fluorescent light was burnt out but the incandescent light fixture was operational.

(5) Shower And Storage Rooms

- Single pane window in storage room, poor caulking.

(6) North Mechanical Room

- Furnace designated for replacement due to leaky heat exchanger - temporarily repaired.

(7) South Mechanical Room

- Oil furnace steady state operating efficiency measured at 65% well below average performance.
- There did not appear to be a stack controller on the furnace flue.
- The furnace filter was plugged with dust.

3.4 Camsell Portage School Maintenance Practices and Evaluation

3.4.1 Interviews

The maintenance personnel for Camsell Portage are located in La Ronge, Saskatchewan. According to the maintenance personnel the school is only visited when there is a major problem with the building or the mechanical systems. Thus, there is no regular service for the school.

3.4.2 Summary Of Audit Teams Observations

Exterior doors:	Require weatherstripping.
Windows:	With wood sash need caulking.
Structural:	The exterior accesses to the crawlspace were not covered and require covers.
Mechanical:	Furnace test
	Draft: .06
	CO2: 7.9
	Temperature: 399^{0}C (743^{0}F)
	Efficiency: 65%
	Filter: Plugged with dust
	Fan belt: Adequate
	Based on the above test the performance of the furnace is below standard and the burner is poor. This low rating is probably due in part to neglect. Dirty furnace filters and dirty heat exchangers dramatically lower the efficiency of heat transfer and result in excessive fuel use. In addition, the burner may be overfiring and needs the nozzle and oil filters replaced. Also, the audit team did not see a stack controller which is essential for safe operation of the furnace
Ventilation:	The furnace filter was very dirty and needs replacement.

Electrical: The lighting system was poorly maintained having several lamps burnt out. Unfortunately a burnt out fluorescent tube will continue to consume electricity as does the ballast for the fixture.

3.4.3 Recommendations

The fact that there is virtually no maintenance program for the Camsell Portage School shows up in the buildings overall condition including the furnaces, mechanical rooms, and lighting systems. There are a number of measures that can be taken to improve the building as well as the efficiencies of the furnace and lighting systems.

- Remove, insulate and seal the ceiling where the exhaust vent is presently installed.
- Weatherstrip the doors.
- Replace all single pane windows with thermally efficient double pane windows.
- Block crawlspace exterior accesses with tight, well fitting covers.
- Lower the temperature of the hot water heater.
- Install high-velocity-low volume shower heads.
- Ensure that fan belts, furnace filters and oil filters are in good condition. Also, that clean replacements are on hand.
- Instruct the caretaker to clean furnace filters as well as the supply and return air registers.
- Replace oil burners with retention head replacement burners including a delayed action solenoid valve between the burner and oil pump.

3.5 Camsell Portage School - Opportunities For Energy Conservation

3.5.1 Energy Conservation Through School Operations

Camsell Portage school is a facility that is well used by the community not only for schooling but for community gatherings. There are ways of conserving energy that simply require modifying the way the building is operated. Once the occupants are made aware of the opportunities, implementing the necessary initiatives should require minimal time and training. The following suggestions are divided into those groups of individuals who will most likely be responsible or have input into the conserving measures.

Principal, Caretaker and Students

- Turn lights, fans and taps off when they are not required. Any dripping hot water taps should be noted so that the maintenance staff can repair the faucet.

- Close the drapes or window coverings after class as this will reduce heat loss through the windows during unoccupied hours. Also, on extremely cold days shutting the drapes should reduce the drafts caused by the windows.

Principal

- For occupied areas set the thermostats at $20^{0}C$ and $15^{0}C$ for unoccupied areas. Each degree the thermostat is turned back results in a 3% reduction in fuel consumption. (ASHRAE 1981)

- Keep the maintenance personnel posted as to condition of weatherstripping and window caulking as well as light bulb and furnace filter supply.

Caretaker

- Vacuum furnace filters at least once a month.

- Check and vacuum supply air registers to remove any items which have fallen in and may be hindering airflow.

3.5.2 Energy Conservation Through School Maintenance

A regular maintenance schedule should be started so that the furnaces will maintain optimum performance and efficiency. The following initial maintenance steps should be taken:

- Install retention head burners in the furnace with a delayed action solenoid valve between the burner and oil pump.
- Service and clean furnaces - including filters.
- Service domestic hot water heater.
- Reduce domestic hot water temperature.
- Install high-velocity - low volume shower heads to reduce hot water consumption.
- Relamp with long life low-watt tubes.
- Install thermally efficient double pane windows.
- Block crawlspace accesses with tight, well fitting covers.

These first steps should be followed by regular annual maintenance visits to:

- Maintain and service furnaces.
- Maintain and service the domestic hot water heater.
- Weatherstrip the doors.

3.6 Initiatives

3.6.1 General

There are a number of initiatives that will contribute to reducing energy consumption in the Camsell Portage school. These include:

- Night setback thermostats.
- Installing retention head burners on furnaces.
- Converting or replacing the oil furnace with propane.
- Replacing single pane windows with thermally efficient double pane windows.
- Relamping with long life low-wattage fluorescent tubes.

These initiatives are detailed below.

3.6.2 Night Setback Thermostats

One of the simplest, most effective energy conserving measures is to lower the room temperature when the room is not in use. This can substantially reduce fuel consumption. A 3% fuel savings is possible per degree celsius the thermostat is set back. The best way to accomplish this saving is to install a clock thermostat. In this way, the school can be maintained at 15^0C during the night and on weekends. Temperatures will automatically rise to 20^0C during school hours.

Assuming that the temperature is setback for approximately 100 hours per week for 40 weeks per school year and assuming that the average outside temperature over the season is -12^0C (from Environment Canada) an estimate of energy saving can be made. Current use of 9,900 L of fuel oil for heating could be reduced to 7,200 L representing savings of $1,250.00 per year (7,200 litres at $.458/litre).

3.6.3 Installing A Retention Head Burner Kit And/Or A Delayed Action Solenoid

This retrofit measure is only appropriate for a furnace with a heat exchanger in good condition.

A retention head burner is designed to produce a superior air-to-oil mix which will significantly improve combustion efficiency. Since the fuel is burning more efficiently higher temperatures are produced making it necessary to install a ceramic fibre liner to protect the combustion chamber. The burner nozzle is also downsized since lower quantities of fuel are required to achieve the same temperatures.

Another feature that should be included is a delayed action solenoid. This device is fitted between the burner nozzle and oil supply pump. When the furnace starts-up it delays the flow of oil to the nozzle for a few seconds allowing the combustion air fan to reach full speed and the oil pump to reach its full operating pressure. When the furnace shuts down, the valve closes instantly, preventing additional oil from leaving the nozzle. In this way, unburned or partially burned oil is prevented from entering the combustion chamber at the beginning and end of each heating cycle increasing efficiency.

This device extends the operating life of the nozzle by preventing clogging with unburned residues. It also allows the furnace to run cleanly with less excess combustion air.

The retention head burner retrofit will cost approximately $750.00 including the delayed action solenoid valve and shipping. This system can effectively raise the steady state efficiency to 85%. If this increased the seasonal efficiency by just 15% these burners could save $340.00 a year per furnace.

The old furnace in the north classroom should be replaced with an oil furnace having these features as the improved efficiency will pay for any extra initial costs. The newer furnace for the south classroom should also be replaced at the same time if it is not in suitable condition to warrant retrofitting.

3.6.4 Convert Or Replace Oil Furnace With Propane

The oil furnace in the north furnace room has been designated for replacement. The heat exchanger had a hole in it and was patched for the interim. The furnace in the south classroom is about ten years old and probably has had no regular servicing. However, it may be in adequate condition to warrant propane conversion.

Since propane is a clean burning fuel, the propane appliance requires minimal maintenance to sustain a high combustion efficiency compared to oil furnaces which usually require regular adjusting, cleaning and servicing to maintain rated efficiency. Therefore, a high efficiency propane furnace could be used at Camsell Portage School and fuel bills reduced by as much as 30% to 40%. The maintenance requirements would also be minimized.

There is, however, a problem with obtaining propane as it is presently barged in from Ft. McMurray, Alberta in 100 pound bottles. The heating requirements for the school would be satisfied with approximately 90 bottles per year. The logistics of safely storing the propane over the winter and changing the propane bottles as required is likely a major drawback to this option.

Providing the fuel can be obtained and used without major difficulties or safety problems, the propane furnaces may be an appropriate investment.

There are a number of very efficient furnaces available on the market. Figure 3.6 describes the different types of propane furnaces and many of the characteristics. Figure 3.7 is a simple cost comparison of each type. It is important that the propane furnace not only have a high steady state efficiency but also a high seasonal efficiency such as the efficiencies achieved by induced draft, condensing and pulse condensing furnaces.

FIGURE 3.6

TYPICAL NATURAL GAS OR PROPANE FURNACE EFFICIENCIES

TYPE OF FURNACE & CHARACTERISTICS	STEADY STATE EFFICIENCY (Lab. or test)	SEASONAL EFFICIENCY (ACTUAL ± 10%)	RELATIVE COST	CONSIDERATIONS
1. CONVENTIONAL ATMOSPHERIC FURNACE -built in or free-standing draft hood -standing (always burning) pilot light.	75%	56%	low	-efficiency is lowest and results in higher fuel costs than the alternatives
2. CONVERSION BURNER -fitted to existing oil furnace -combustion air supplied by fan	75%	63%	lowest	-this is the lowest cost conversion and usually delivers higher efficiencies than the above. -fan controlled combustion air and large heat exchanger found in oil furnaces accounts for this improvement. -oil furnace must be compatible and in good condition.
3. IMPROVED ATMOSPHERIC FURNACE - spark ignition lights pilot only when needed -vent damper closes vent when furnace is not firing (natural gas only)	75%	67%	medium	-vent damper reduces loss of heated house air up chimney during the off cycle for safety reasons, propane burning equipment may not be equipped with a vent damper at this time.

Source: The Billpayer's Guide to Heating Systems. Energy, Mines and Resources Canada, April 1983.

Figure 3.6 Continued

TYPE OF FURNACE & CHARACTERISTICS	STEADY STATE EFFICIENCY (Lab. or Test)	SEASONAL EFFICIENCY (Actual ± 10%)	RELATIVE PURCHASE COST	CONSIDERATIONS
4. INDUCED DRAFT FURNACE -high efficiency noncondensing heat exchanger -combustion air supplied by fan -chimney and draft hood eliminated -spark ignition	83%	79%	moderately high	this furnace can reduce fuel costs by about 25% compared with conventional equipment -elimination of extra heat exchanger surface lowers costs -needs no chimney and eliminates costs for up grading the chimney (liners) and can free an existing chimney for wood, etc. -safety improved by draft sensing controls
5. CONDENSING FLUE GAS FURNACE -second heat exchanger tracps heat from combustion by-products -combustion air supplied by fan -chimney and draft hood eliminated -spark ignition	90%	89%	High	-this furnace costs two to three times as much as an atmospheric model -it will reduce fuel costs by more than one third compared to conventional equipment -same benefits gained by elimination of chimney
6. PULSE COMBUSTION -utilizes automotive-like combustion process, using spark plug for ignition -eliminates need for combustion air fan and conventional chimney -condensation extracts heat from combustion by-products	90%	89%	high	-this is the most fuel efficient option and it is available in both forced air and boiler models - the efficiency of this system is unlikely to be surpassed in the foreseeable future -in the boiler model, temperature of circulating water must be low enough to allow condensation of flue gases.

Source: The Billpayer's Guide to Heating Systems, Energy, Mines and Resources Canada, April 1983.

FIGURE 3.7

COST COMPARISON OF PROPANE FURNACES

Type of Furnace	Seasonal Efficiency	Make & Model	Output per Furnace (BTU/hr)	Capital Cost 2 Furnaces ($)	Estimated Consumption (Litres/Year)	Cost of Fuel (Oil $0.458/L) (Propane $0.433/L)	Dollar Savings ($/Year)	Payback (Years)
Present Oil Furnaces	50%	---	---	Nil	9,900 (oil)	$4,550	Nil	Nil
Upgrading Oil Furnaces	60%	---	---	$1,500.	8,420 (oil)	$3,880	$690	2.2
Propane Conversion Burner	63%	---	---	$1,400	11,500	$4,980	None	None
Improved Atmospheric	67%	Olson Mini Max	100,000	$2,000	10,820	$4,680	None	None
Induced Draft	79%	Airco Turbo	100,000	$2,600	9,170	$3,970	$580	4.5
Condensing Flue Gas	89%	Mega Save	120,000	$3,600	8,140	$3,530	$1,020	3.7
Condensing Flue Gas	89%	Olson Ultra	90,000	$3,200	8,140	$3,530	$1,020	3.2
Pulse Condensing	96%	Lennox	100,000	$4,000	7,550	$3,270	$1,280	3.2

Footnotes:

1. Present oil Furnace - Shows the estimated fuel oil consumption and fuel costs oil the schools heating systems are not improved or replaced.
2. Upgrading oil furnaces - shows the estimated capital cost, fuel oil consumption and fuel oil costs that could be expected if both furnaces were upgraded with retention head burners and delayed.
3. Is the seasonal efficiency of each furnace type.
4. The capital cost is the approximate cost for two furnaces and does not include costs for shipping and installation.
5. The estimated consumption is based on the estimated annual heating requirement of the school being 18.9×10^7 kJ/yr. and that the heating value of one litre of propane is 2.6×10^4 kJ/L.
   The base heating requirements if the heating system were 100% efficient is 7248 L per year.
6. The cost of fuel is based on 1984 prices as of November $0.458/L for fuel oil and $0.433/L for propane.
7. The dollar savings is the savings achieved per year as a result of installing or improving the present furnaces.
8. Payback was calculated by: Capital Cost - Savings/Year.

3.6.5 Replacing Single Pane Windows With Thermally Efficient Double Pane Windows

Camsell Portage school has four windows which are single pane, glass mounted in woodframes. The window panes are loose in the frames and need caulking around the edges. One window is missing completely and has been replaced with a piece of plywood. Single pane windows are a major source of heat loss particularly when the glass is not sealed to the frame. Some of the heat loss could be reduced through yearly maintenance which involves scrapping off the old, cracked caulking and replacing it with new caulking.

The other option is to replace the old windows with new double pane windows in thermally efficient aluminum frames. The windows are 0.9 m X 1.5 m and would cost approximately $170.00 each for $680.00 total. The savings would be approximately $205.00/year with a payback time of 3.3 years. This calculation did not include savings due to reduced infiltration.

3.6.6 Relamping With Long Life Low-Wattage Fluorescents

The present lighting system provides adequate light levels for the classrooms. However, there were several blackened lamps which consume electrical energy although no light is being provided.

Long life tubes are recommended for the following reasons.

- They are available in 34W tubes which reduces electrical consumption with a minimal reduction in light output compared to 40W tubes.

- They have a minimum operating life of 24,000 hours which is about 8 school years and are guaranteed for 2 1/2 years. Due to the longer life minimized maintenance, caretaking and shipping expenses are reduced.

Since Camsell Portage school is operated on the basis of "no regular maintenance" a better quality light tube will save the school board $470/year in electrical costs. Additional savings will be realized due to fewer number of shipments of tubes and less caretaking. The cost to install the long life tubes will be approximately $1,036.00 and with the expected electrical savings the lamps will be paid off in just over two years which is just under the warranty period.

A brand name for this type of tubes is: Vita-Light.
A detailed cost analysis is provided in Figure 3.5

FIGURE 3.8

ENERGY SAVINGS LONG LIFE LOW WATTAGE FLUORESCENTS @ 34 W TUBE

Total Number of Lamps — 74 Lamps

Cost to Install: — $14.00/Lamp

Total Cost: 74 lamps X $14.00 = $1,036.00

Power Savings/Lamp : (40W - 34W = 6W)

TOTAL POWER SAVINGS/YEAR

6W X 74 lamps X 14 hours /day X 200 days/yr X .001 kWh/W = 1,243 kWh/year

Dollar Savings = $.38/kWh X 1,243 kWh/year = $472/year

Simple payback period = $1,036 / $472 = 2.20 years

FIGURE 3.9

ENERGY CONSUMPTION AND COST

Room	#of Fixtures	#of Lamps Per Fixture	Wattage	Wattage Including Ballast	Hrs/day (kWh) kWh	Days/Yr	Annual Consumption (kWh)	Annual Cost (@ $0.38/ KWh)
South Classroom	16	@ 2 X	F40	1440	14	200	4,032	1,530
North Classroom	16	@ 2 X	F40	1440	14	200	4,032	1,530
Entrance	1	@ 2 X	F40	90	14	200	252	95
	1	@ 1 X	150	150	14	200	420	160
Wash-room/ Shower	4	@ 2 X	F40	360	14	200	1,008	380

F40 - Indicates a 40 W fluorescent tube

FIGURE 3.10

SUMMARY TABLE OF MEASURES THAT WILL CONTRIBUTE TO ENERGY CONSERVATION

OPTION	FUEL REQUIREMENT (L/YR)	FUEL Cost/yr (Oil $0.458/L)	CAPITAL COST OF OPTION	LIFECYCLE[1] OF FUEL OVER 15 Years	NET SAVINGS[2] OVER 15 YEARS
FUEL OIL					
No Action	9,900	$4,550.00	0	$55,290.00	0
Night Set-Back Thermostat	7,200	$3,300.00	$160.00	$40,100.00	$15,030.00
Replacing Windows	9,570	$4,380.00	$680.00	$53,290.00	$1,320.00
Installing Retention Head Burners	8,415	$3,850.00	$1,400.00	$46,830.00	$7,000.00
Installing Propane Pulse Furnaces	7,395	$3,200.00 (Propane $0.433/L)	$4,000.00	$38,910.00	$12,380
ELECTRICAL		kWh electricity ($0.38/kWh/yr)			
No retrofit	13,500	$5,130.00	0	$62,380.00	0
Low-Wattage Fluorescent Tubes	12,260	$4,660.00	$1,060.00	$56,650.00	$4,670.00

Notes:

1. Life cycle cost calculation assumes an interest rate of 8% and an escalation rate of 5%.

2. Net savings are determined by assuming capital costs are paid for in the first year:
   (No action - option - capital cost) = Net savings.

   (No action fuel cost over 15 years - capital cost of option - Option fuel cost over 15 years) = Net Savings.

3. Savings are not additive. They are based on a single change to the present system, as each is implemented the potential savings is diminished.

3.7 Energy Conservation Action Plan

3.7.1 Measures Which Require No Capital Investment And Delivers Immediate Savings

Maintenance:

- Remove, insulate and seal over ceiling exhaust vent in North classroom.
- Block crawlspace access with tight, well fitting covers.
- Lower temperature of the hot water heater.
- Service and clean furnaces and burners if they are not immediately replaced.

Principal, Caretaker and Students:

- Install heating fuel meter for monitoring monthly fuel oil consumption.
- Turn lights, fans and taps off when they are not required.
- Close drapes after class.
- Setback thermostats manually to 21^0C - 20^0C for occupied areas and 15^0C for unoccupied areas.
- Vacuum furnace filters.

3.7.2 Measures Requiring Capital Investment

- Weatherstrip doors and caulk windows; cost is approximately $45.00 per year.
- Install automatic night setback thermostats which will cost $160 and save as much as $1,200 per year.
- Install efficient shower heads that give a high-velocity - low volume flow of water. This will save hot water and therefore energy. Manufacturers claim costs can be reduced by 50% which could be a $350/yr savings. (See Appendix E for manufacturers literature.)

- Upgrade oil furnaces by installing retention head burners and delayed action solenoid valves and save $690 per year.

- Convert or replace oil furnaces with propane. Save as much as $1,300 /year and reduce maintenance requirements.

- Replace single pane windows with double pane windows and save as much as $300 per year.

- Relamping with low-wattage long life tubes for electrical savings of approximately $470 per year.

3.7.3 Summary of Measures

To initiate any of the above recommendations Camsell Portage school will require a service visit from the maintenance crew. In this way all of the no cost recommendations can be implemented and the school building will be in the most energy efficient condition possible without any capital outlay. However, for a minimal capital cost night setback thermostats, weatherstripping and caulking may be purchased and installed. The savings from a night setback thermostat are such that it will have paid for itself in less than two months. The total savings from all the recommendations is not additive, that is, as each measure is implemented the potential savings from unadopted meansures is diminished.

The oil furnace for the north classroom has been designated for replacement. Before a new furnace is purchased, careful consideration should be given to the following:

- Replacing the existing oil furnace with a high efficiency oil burner and simultaneously upgrading the furnace in the south mechancial room by installing a retention head burner and a delayed action solenoid valve.

- Replacing both existing oil furnaces with high efficiency oil burning furnaces.

The other capital cost recommendations are the installation of double pane windows and relamping with long life low-wattage fluorescent tubes. Both of these recommendations will conserve energy and should reduce maintenance and caretaking.

3.8 The Energy Budget

3.8.1 General

The true effect of an energy conservation program can only be measured if past and current fuel consumption is accurately documented. This section presents a historical perspective on the Camsell Portage School fuel use. Based on this historical data an energy budget of current energy consumption was developed. The budget provied a measure for conservation initiatives and reflects energy use before any changes take place.

The final portions of this section present a method to monitor and document energy use so that the success of a conservation plan can be evaluated on an annual basis. This method allows an accurate comparison of fuel bills by adjusting portions of the energy use to actual climatic factors (degree days). The approach is relatively simple, and could be used by the school principal or some other member of the school board. This approach also forms a very good foundation for an energy incentive program.

3.8.2 Historical Energy

Electrical and fuel oil consumption for 1982, 1983, 1984 are listed in figure 3.11 In addition, since electricity is measured and billed on a monthly basis the annual consumption was graphed in figure 3.12.

The electrical consumption for 1983 is as one would expect. That is, higher in the winter months since furnace fans and pumps are operating more frequently. Consumption gradually declines over spring and is very low in the summer when the building is unoccupied and heating is not required.

Since the fuel oil is not supplied on a demand basis a similar representation as that in figure 3.12 cannot be shown.

FIGURE 3.11

FUEL ENERGY

Electrical 1982, 1983, 1984.

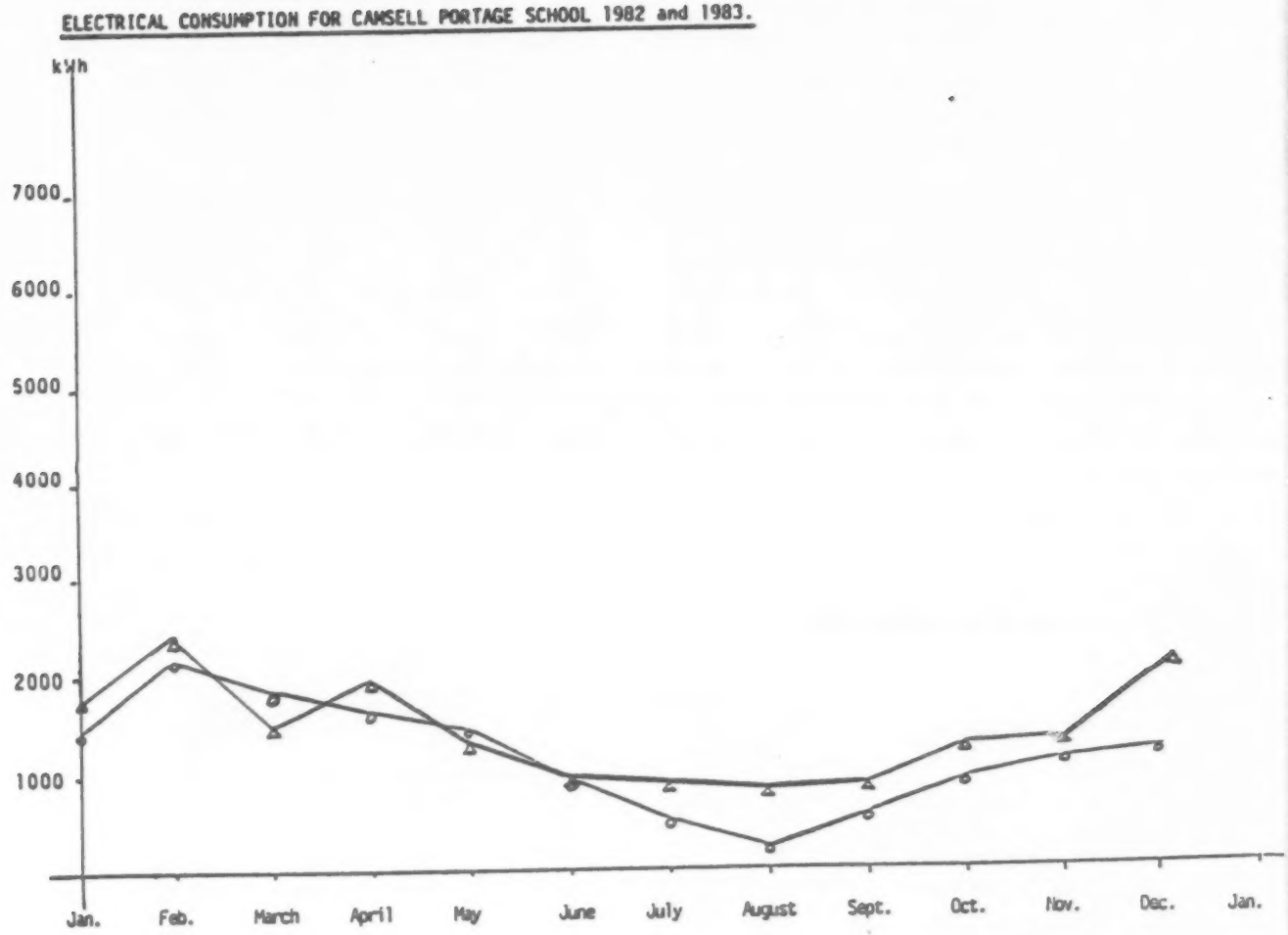
Month	KWH 1982	COST ($)	KWH 1983	COST ($)	KWH	COST $
JANUARY	1,739	602.59	1,452	503.12	4,262	1,268.82
FEBRUARY	2,182	756.06	2,019	699.58	1,961	782.44
MARCH	1,518	525.99	1,683	583.16	1,811	722.59
APRIL	1,824	632.02	1,625	563.06	1,811	722.59
MAY	1,380	478.17	1,367	473.67	682	272.12
JUNE	995	344.77	974	337.49	741	295.66
JULY	808	279.97	496	197.90	750	285.00
AUGUST	748	259.18	199	79.40	389	156.24
SEPTEMBER	792	274.43	524	209.08	627	256.76
OCTOBER	1,230	426.20	851	339.55	N/A	N/A
NOVEMBER	1,265	438.32	1,053	420.15	N/A	N/A
DECEMBER	1,826	632.71	1,082	431.72	N/A	N/A
TOTALS	16,307	$5,650.41	13,325	$4,837.88	13,034	$4,762.22

Oil 1982, 1983, 1984.

Month	LITRES 1982	COST ($)	LITRES 1983	COST ($)	LITRES 1984	COST ($)
JANUARY	2,025	880.00	1,418	858.00		
FEBRUARY						
MARCH						
APRIL	2,430	1,155.60	2,22	1,248.00	2,633	1,638.00
MAY	2,025	880.00			405	234.00
JUNE						
JULY			2,835	1,638.00		
AUGUST						
SEPTEMBER						
OCTOBER						
NOVEMBER	1,823	1,053.00	1,418	819.00		
DECEMBER	1,620	936.00				
TOTALS	9,923	$4,904.60	9,317	$4,563.00	3,038	$1,872.00

FIGURE 3.12

Graph of Electrical Use



KEY

△ 1982

○ 1983

3.8.3. Monitoring The Energy Consumption

The procedure outlined below will allow the Northern Lights School Board to compare energy usage from year to year to determine the effectiveness of any conservation initiatives undertaken. Once goals for conservation are set by the school board they can be evaluated on an annual basis. If desired new goals can be set every year.

The approach used to determine annual energy savings is designed to compensate for climatic variations occurring from year to year by using a degree day adjustment factor. Degree days are measured by Environment Canada and are available on a monthly basis!

In order to accurately determine the impact of conservation initiative on fuel usage, it is essential that actual fuel usage be monitored on a monthly basis. As a result, a fuel meter will have to be installed somewhere between the fuel storage tanks and the furnaces. It will also be necessary for the principal to record the monthly consumption. Additionally it is recommended that the principal be responsible for performing the monthly calculation of savings outlined below. The fuel meter should be installed during the next maintenance visit to the Camsell Portage School.

Please Note:

The process of monthly evaluation of fuel use is intended primarily to provide a benchmark of conservation progress to the staff, students and maintenance personnel of the school. Fluctuations in energy use may occur on a monthly basis that are cancelled out at the end of a year. As a result the true effectiveness of a conservation program is best evaluated at the end of a complete year of monitoring.

This method is designed to compliment any conservation incentive program that the school board might wish to embark upon. Careful monitoring is essential to an effective incentive program.

3.8.4 Calculation Of Monthly Fuel Usage And Savings

- Phone Environment Canada, Climatic Services Department and obtain the actual degree days for the month and record in column 3 in figure 3.14 for the appropriate month.

- Using the form provided in figure 3.13, calculate the estimated fuel consumption based on past energy use. The only information you will need to calculate is the estimated fuel consumption for the number of degree days for that month.

  Fill in the estimate into column 4 in figure 3.14 for the appropriate month.

- Note the actual fuel meter reading (from fuel meter) in column 5 of figure 3.14. Reading should be taken at the beginning of each month.

- Calculate the actual amount of fuel used for the month by subtracting the previous months' meter reading from the current months' meter reading (both in column 5) and insert the result in column 6.

- Calculate the fuel savings that has occurred based on past energy use (adjusted for climatic variation) by subtracting the Actual Energy Use (column 6) from the Estimate Of Energy Use (Column 4) and insert the result in the appropriate month (in column 7).

  (Estimate Of Energy Use - Actual Energy Use) = Savings

- To calculate the percentage savings for the month divide the fuel savings (column 7) by the estimate of fuel consumption (column 4) and multiply by 100.

  (Savings ÷ Estimate Of Fuel Consumption x 100%) = Percentage Savings

- Once an entire year's fuel usage has been recorded, total the figures in columns 3, 4 and 5 and the savings for the entire year using steps outlined above.

FIGURE 3.13

CALCULATING MONTHLY ESTIMATE OF FUEL CONSUMPTION

BASED ON PAST FUEL USAGE

CAMSELL PORTAGE SCHOOL

i) Month: _____

11) Degree Days for Month: _____
(From Environment Canada Climatic Services)

111)[1] Oil Furnaces Fuel Usage

_____ degree days X 1.15 L/degree day = _____ litres # 2 fuel oil

The estimated consumption= litres

The Imperial Conversion is:

_____ litres ÷ 4.5 = _____ gallons

Or: For Propane furnaces:

_____ degree days X 0.56 L/degree day = kilograms propane

_____ kilograms X 1.92 L/kilogram = _____ L of propane.

NOTE:

The constants 1.15 and 0.56 are derived from the heat loss characteristics of the school, the estimated seasonal efficiency of the heating system and the heating value of the fuel.

FIGURE 3.14

ENERGY MONITORING CHART FOR FUEL OIL FOR CAMSELL PORTAGE SCHOOL

	1	2	3	4	5	6	7	8
	1984 For Comparison Purposes Only							
Month	Normal Heating Degree Days	Fuel Consumption (Litres)	Actual Heating Degree days (Celsius)	Estimate of Fuel Consumption (litres)	Fuel Meter Reading (litres)	Actual Fuel Usage (litres)	Fuel Savings (Litres)	Percent Fuel Savings (%)
January	1,395	1,600						
February	1,140	1,310						
March	1,042	1,200						
April	631	730						
May	348	400						
June	142	160						
July	74	90						
August	116	130						
September	321	320						
October	537	620						
November	884	1,020						
December	1,231	1,420						

1. Normal heating degree days are thirty year Environment Canada Climatic Services.
   Estimated fuel consumption is derived by multiplying the Normal heating degree days by 1.15 L/Degree Day which is an estimated constant based on heat loss characteristics of the school, seasonal efficiency of the heating system and heating value of the fuel.
3. Actual heating degree days from Uranium City Climatic Services.
4. Estimate of fuel consumption is obtained by multiplying :
   (Actual heating Degree Days X 1.15 L/Degree Day).
5. Fuel consumption is read from the fuel oil line meter.
6. The actual fuel consumption for the month is obtained by:
   (current oil meter reading-last oil meter reading)
7. Savings is calculated by: (Theoretical consumption - actual consumption).
8. Percentage of Fuel Savings is calculated by:
   (Fuel Savings ÷ Estimate of Fuel Consumption x 100%).

3.8.5 Calculation of Monthly Electical Usage and Savings

The largest portion of the electrical bill is attributed to the lighting load. The amount of time the lights are on is fairly consistent throughout the school year. The remaining portion of the electrical bill is made up of electrical requirements of the fans and pumps necessary for heating and ventilating. This load fluctuates with the heating requirement of the building and, therefore, the outside temperature. So, as temperatures drop the electrical load will increase.

An estimate of the base electrical consumption for the school requires an estimate of the hours of lighting operation. Also an estimate of the electrical load due to the fans and pumps used by the heating system. This load fluctuates with the heating demand.

For this reason the base electrical consumption calculation is divided into two parts:

- The first is to estimate the hours lights were actually on for the billing period. Then multiply hours of operation by 0.345 kW/hour.

- The second is to estimate the consumption due to the heating requirement by mutiplying degree days by 0.345 kWh/DD.

Figure 3.15 is a step-by-step method for determining the estimated electrical consumption and figure 3.16 is for recording monthly consumption and savings.

FIGURE 3.15

CALCULATION OF ELECTRICAL USAGE AND SAVINGS

CAMSELL PORTAGE SCHOOL

1. Record the monthly electrical reading from the electrical meter at the beginning of each month and calculate electrical usage since the last reading.

2. Insert the degree days for the month into Column 2 of figure 3.1.6.

3. Estimate the amount of electricity used due to furnace fans and pumps and insert into Column 3 of figure 3.16 for the appropriate month.

   To estimate electrical use:

   Degree Days x 0.345 = kWh

4. Estimate the number of hours lights were on during the entire month.

   i. Lights on for _____ hours per days

   ii. Lights used for _____ hours per month

   Total number of hours lights on = hours/days lights on X days/months lights on

   = _____ hours/day x _____ days/month

   = _____ hours/month

   Insert the total number of hours into Column 4 of figure 3.16

5. Estimate the actual amount of electricity used for the month using the following formula:

   Lighting Energy = Hours/month lights on X 3.458

   = _____ hours/month X 3.458

   = _____ kWh

   Insert the estimate of elctricity used for lighting into Column 5 of figure 3.16.

6. Add the estimated electrical consumption for furnace fans and pumps to the estimated consumption for lighting to obtain the total estimated electricity consumption.

   Insert this total into Column 6 of figure 3.16

7. Note the actual electrical meter reading in Column 7 of figure 3.16. The reading should be taken at the beginning of each month.

8. Calculate the actual amount of electricity used for the month by subtracting the previous month's meter reading from the reading for the currect month. Insert the total actual electrical used in Colulmn 8 of the appropriate month.

9. Calculate the electricity savings that have occurred based on past electrical use (adjusted for climatic variation) by subtracting actual electrical consumption (Column 8) from total estimated electrical consumption (Column 6).

   (Total Estimated Electrical Consumption - Actual Electrical Consumption) = Savings

10. To calculate the percentage savings of electrical energy for the month divide the electrical savings (Column 9) by the total estimated consumption (Column 6) and multiply by 100.

    (Electrical Savings ÷ Total Estimated Consumption x 100%) = Percentage Savings

    Insert the calculated savings into Column 10 of figure 3.16

11. Once an entire year's fuel usage has been recorded, total the figures in Columns 2, 6 and 8 and calculate savings and percentage savings of electricity for the entire year using steps above.

Figure 3.16

ELECTRICAL MONITORING CHART FOR CAMSELL PORTAGE SCHOOL

	1	2	3	4	5	6	7	8	9	10
Month	Base Estimate	Actual Heating Degree days For Month (°C)	Estimated Electricity due to Furnace Fans + Pumps kWh	Estimated Hours Lights on One Month (Hrs.)	Estimated Lighting Electricity Consumption kWh	Total Estimated Electrical kWh	Electrical Meter Reading kWh	Actual Electrical Consumption (Current reading - last reading) kWh	Electrical Savings	Percentage Electrical Savings (%)
January	1,550									
February	1,460									
March	1,430									
April	1,290									
May	1,790									
June	650									
July	430									
August	440									
September	710									
October	1,250									
November	1,380									
December	1,500									

1. Base estimate is for comparison only do not use for calculating savings.
2. Actual heating degree days may be obtained from Uranium City Climatic Services Office.
3. Estimated electricity consumed by the furnace fans and pumps: (Actual Heating Degree Days x 0.345 kWh/Degree Day)
4. Hours/lights on - is the number of hours the majority of the lights are on per billing period.
5. Estimated electrical consumption is obtained from the following calculation which is: (3.458 kWh/hour X hours lights on).
6. Total Estimated Electrical Consumption is: (Column 3 + Column 5)
7. Electrical meter reading.
8. Actual Electrical Consumption: (current meter reading - last meter reading)
9. Electrical Savings is calculated by: (Estimated electrical consumption - Actual electrical consumption)
10. Percentage of electrical savings (Electrical savings + Esimated electrical x 100%)

3.9. The Budget

Figure 3.17 presents an energy budget developed by the audit team for the Camsell Portage School. The budget represents energy consumption at the school before any conservation initiatives are taken. Based on the budget conservation goals can be set. Depending on the conservation initiatives adopted a good general goal for the first year of a conservation program is 15-30%.

Energy consumed in future years can be measured against the energy budget and the actual percentage savings on a yearly basis can be calculated. The method presented in section 3.8 allows for accurate comparison of year to year fuel bills by adjusting consumption figures to take into account climatic variations (eg. unusally warm or mild winter months.)

FIGURE 3.17

CAMSELL PORTAGE ENERGY BUDGET

Month	Fuel Consumption (litres)	Electrical Consumption (kWh)
January	1,600	1,550
February	1,310	1,460
March	1,200	1,430
April	730	1,290
May	400	1,790
June	160	650
July	90	430
August	130	440
September	370	710
October	620	1,260
November	1,020	1,280
December	1,420	1,500
Total	9,050	13,790

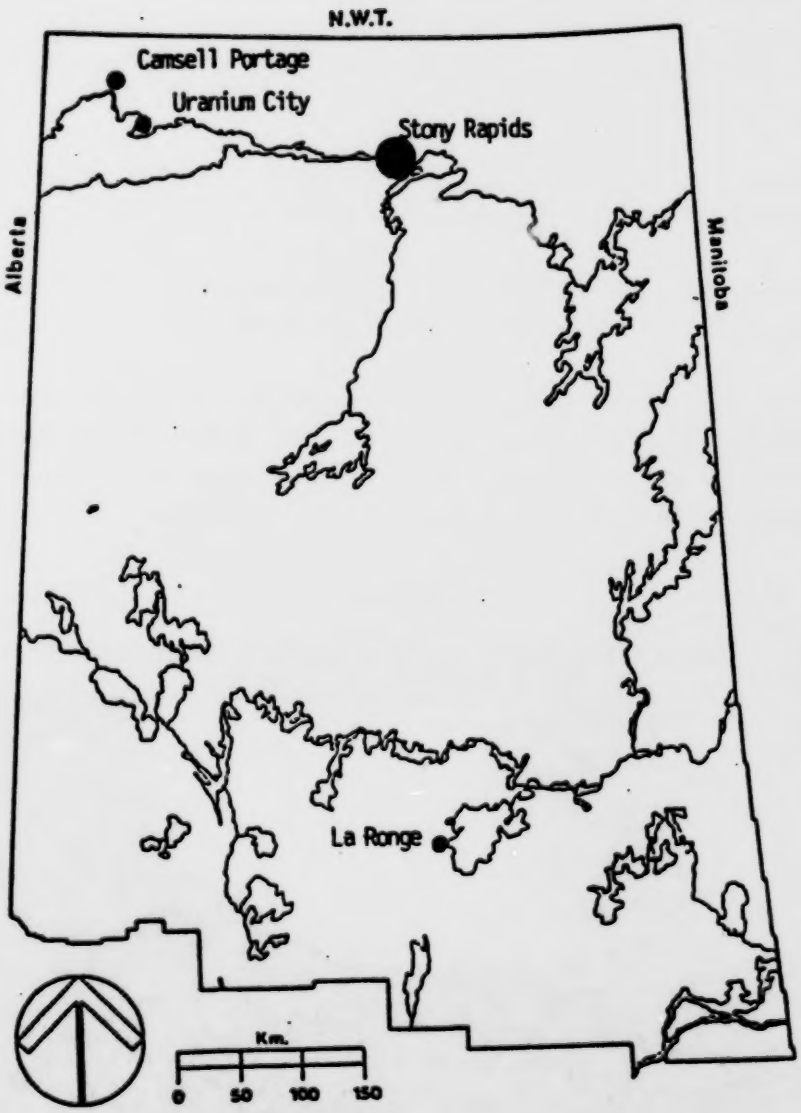
STONY RAPIDS SCHOOL

STONY RAPIDS SCHOOL ENERGY AUDIT

4.1 Background

Figure 4.1

Location of Stony Rapids



Stony Rapids is located in Northern Saskatchewan at 59.2 ^{0}N latitude, approximately 120 km from Uranium City. The community of Stony Rapids is classified as a remote community and is only readily accessible by air. Some supplies such as fuel oil are supplied to the community in bulk via a summer barge. All electricity in the community is provided by a diesel generator operated by Saskatchewan Power. The school does have a backup generator to provide power to the furnace fans and pumps in case of an emergency.

The majority of Stony Rapids residents heat their homes with wood. The school is heated with fuel oil purchased from the local bulk supplier. The school is one of the few sources of running hot water in the community and as a result, members of the community make use of the school's shower facilities.

There are approximately 350 residents in the community and an average of 80 - 90 students in the school during a regular school day.

The school building itself is very large and includes a full sized gym, industrial arts area, library and five classrooms.

Data for this energy audit was collected during an on-site inspection conducted on December 18, 1984. The outside temperature at the time of the audit was -42^{0}C. Degree days for Stony Rapids as measured in Uranium City are 8210^{0}C degree days.

Figure 4.2

Stony Rapids School "The link between the gym on the south and the classrooms on the north

4.2 School Characteristics

4.2.1 Energy Consumption For 1982 and 1983

Energy Consumption figures for 1982 and 1983 are presented in figure 4.3. This information was obtained by the audit team from the electrical and fuel oil bills on file at the Northern Lights School Board Office.

Figure 4.3

Annual Energy Consumption: Stony Rapids School (1982-83)

Energy Type	1982 Consumption	1982 Cost ($)	1983 Consumption	1983 Cost ($)
Electricity (kWh)	117,600	40,750	112,870	39,740
Fuel Oil (litres)	102,060	29,870	94,350	26,500
Total	--	70,620	--	66,240

Notes:
1. Numbers have been rounded
2. 1982 Electrical prices were $0.347/kwh
   1982 Fuel oil prices were $0.293/l
3. 1983 Electrical prices were $0.352/kwh
   1983Fuel oil prices were $0.281/l

4.2.2 School Size

- Stony Rapids school has a heated area of 2061 m^2 (22,187 sq. ft.) which costs, in 1983 dollars $32/$m^2$ to light and heat.
- The exterior wall area is 784 m^2 (8,444 sq. ft.) and is largely wood frame construction with a brick exterior.
- Window area is 53 m^2 (566 sq. ft.) which is approximately 6.5% of the wall area.
- An average 80 to 90 students occupy the school during a regular school day.

4.2.3 Estimated Building Heat Loss

Figure 4.4 represents a breakdown of estimated building energy loss for the Stony Rapids School attributable both to building heat loss and ventilation losses. Estimated fuel consumption was derived from climatic and fuel data for the period of July 1983 to June 1984. As can be seen from Figure 4.4, estimated losses due to ventilation and natural infiltration account for 66% of total building heat losses. Given the vintage of the school this figure is rather high. Possible causes for the high ventilation level are examined later in this report.

Figure 4.4

Estimated School Building Heat Losses For July 1983 to July 1984*

Heat Loss Type	kWh	Fuel Oil** Consumption (litres)	Cost ($)	% of Total Heat Loss (%)
Envelope Heat Losses	389,000	36,500	15,100	34
Ventilation & Infiltration Heat Loss	762,300	71,500	29,500	66
Total Heat Loss	1,151,300	108,000	44,600	100

* Calculation based on degree days for Uranium City (8210^{0}C degree days)

** Estimate for fuel oil based on 60% seasonal operating efficiency and a fuel cost of $0.49/litre.

Figure 4.5

Operating Hours

	MON.	TUES.	WED.	THURS.	FRI.	SAT.	SUN.
8:00 a.m to 5:00 p.m.	80 to 90 occupants					------	unoccupied
6:00 p.m.	2 occupants					unoccupied	unoccupied
7:00 p.m. to 10:00 p.m.	approximately 20 occupants					unoccupied	unoccupied

The entire school is used and is at its maximum occupancy until 5:00 p.m. from Monday through Friday. The janitors (2) clean the classrooms during the week from 6:00 p.m. until 10:00 p.m. The community uses the shop and gym during the week between 7:00 p.m. and 10:00 p.m.

All the furnace thermostats are left at occupancy settings (21^{0}C to 22^{0}C) twenty-four hours per day. At the time of the audit, the fans on the gym furnaces were set to run continuously. The heating system for the shop area is set to supply one hundred percent fresh air continuously.

The interior lights are usually shut off after hours. Staff, caretakers and community have been instructed to turn lights out upon leaving the building.

4.3 The On-Site Audit

4.3.1 Introduction

The on-site audit procedure involved 4 major tasks:

- An interview with the school principal
- An exterior inspection of the structure and its combustion flues and vents
- A room by room walk-through inspection of the building
- A review and inspection of mechanical systems and operating controls, including the testing of the operating efficiency of a number of furnaces.

4.3.2 Interview With The School Principal

Discussions with the principal provided the audit team with a general knowledge of the building occupancy, use and idiosyncrasies. It also indicated that the principal had a good understanding of the energy systems and that with control operating instructions and energy guidelines, could easily operate an energy conserving system (such as night setback thermostats, etc.)

Since the maintenance personnel for Stony Rapids School are located in La Ronge 350 km south of Stony, the principal is responsible for the day to day operations of the heating systems which incorporates:

- 16 oil furnaces in 4 different mechanical rooms.
- Several networks of ducting requiring some 24 fans to move the heated air and provide adequate ventilation.

Due to the remoteness of the maintenance staff the school, at times, has had to function without a furnace or furnaces for a day or more. Hence, the principal is often called upon in these circumstances to undertake makeshift repairs.

Using a night setback thermostat for automatic temperature control was acceptable to the principal although he was concerned about plumbing pipes freezing. According to the principal, temperatures had been set back manually, however, the pipes froze in the ceiling space above the main entrance. Investigations during the audit turned up a number of reasons why the temperature in this area is not maintained at the thermostat setting. (See Appendix C - Main Entrance for details). There was also no objection to turning back the temperature of the hot water heater.

Additional areas of energy consumption, as pointed out by the principal, are the clothes dryers, car plug-ins, and the toilets which often run for a day or more due to malfunctioning floats and flush mechanizms.

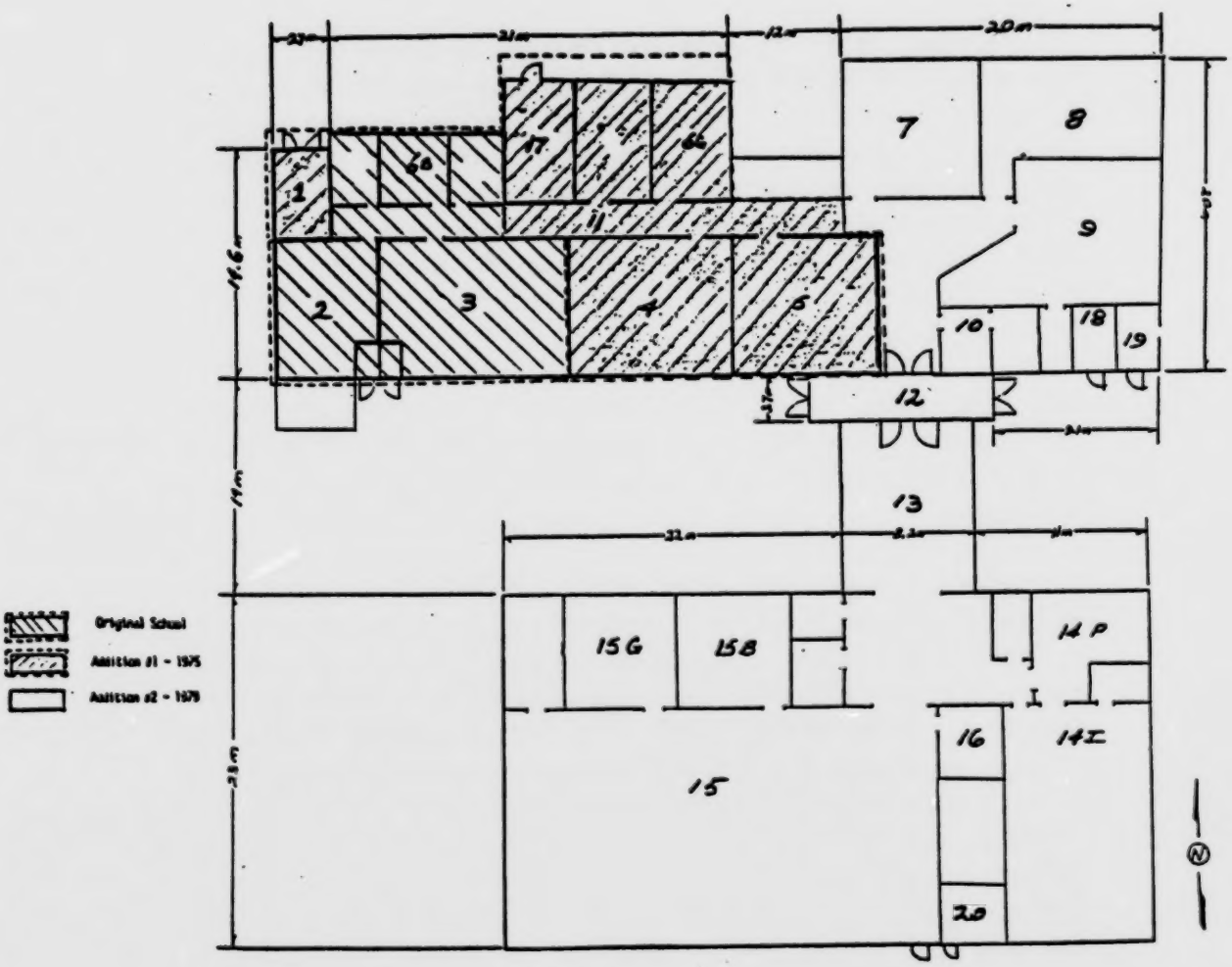
The principal was concerned about the school's energy consumption and had at one time proposed an energy conservation incentive plan to the school board where money saved in energy could be applied to the purchase of new books for the school library. It appears that the incentive program did not work very well because a format for monitoring energy use and calculating actual savings (based on climatic variation from year to year) was not incorporated into the incentive program. At the end of the year, it was difficult to determine actual savings due to conservation activity and a savings due to a milder winter. As a result of this discussion the audit team has developed a monitoring program for the schools that considers climatic differences from year to year. This method is presented in the last section of the school report.

4.3.3 Room by Room Audit Inspection

A summary of the findings of the walk-through audit is provided below. More detailed audit report forms of the Stony Rapids School can be found in Appendix C of this report. A floor plan of the school is presented in Figure 4.6

Figure 4.6

FLOOR PLAN OF STONY RAPIDS SCHOOL



KEY

1. Northwest Entrance
2. Science Lab
3. Classroom
4. Home Economics Room
5. Kindergarten
6. Boys and Girls Washroom
7. Classroom
8. Classroom
9. Resource Centre
10. General and Principals Office
11. Classroom Hall Way
12. Main Entrance Vestibule
13. Link & Gym Vestibule
14. Industrial Arts & Plastics Lab
15. Gym, Girls & Boys change rooms
16. Stage Storage
17. North Mechanical Room
18. Mechanical Room
19. Generation Room
20. Mechanical Room

(1) Northwest Entrance

- This entrance is used by all the occupants.
- The bottom of the outside door needs weatherstripping.
- The outside door does not close tightly unless extreme force is used, and as a result the door is often left ajar.
- The lighting levels should be reduced from 645 lux to 100 lux.

(2) Science Lab

- The windows are single pane in wood frames.
- Lighting levels should be reduced from 860 lux to 500 lux for the classroom,and from 1,130 lux to 750 lux for the instructors desk.
- Five fixtures had burnt out.
- There is an attached greenhouse with a window broken.
- The door to the greenhouse needs weatherstripping.

(3) Classroom Next To The Science Lab

- The windows are single pane in wood frames.
- Lighting levels should be reduced from 730 lux to 500 lux.
- Four fixtures had burnt out.

(4) Home Economics Room

- The windows are single pane in wood frames.
- Light levels should be reduced from an average of 695 lux to 500 lux.
- Three light fixtures had burnt out lamps.
- There was a thick frost build up on the range exhaust hood.

(5) Kindergarten Classroom

- The windows are single pane in wood frames.
- Lighting levels should be reduced from 780 lux to 500 lux.
- Three light fixtures had burnt out lamps.

(6) Boys And Girls Washrooms

- The window in the boys washroom is single pane in a wood frame.
- Lighting levels should be reduced from 645 lux to 250 lux.
- The girls washroom had a strong smell of fuel oil.

(7) West Northeast Classroom

- The windows are single pane sliders with storm sliders.
- The lighting levels should be reduced from 724 lux to 500 lux.
- Five light fixtures had burnt out lamps.
- This room tends to overheat as the temperature is controlled by a thermostat in the adjacent room.

(8) Northeast Classroom

- The windows are single pane sliders with storm sliders.
- The lighting levels should be reduced from 750 lux to 500 lux.
- One light fixture had burnt out lamps.
- This room tends to be too cool for occupants.

(9) Resource Centre And Work Room

- The windows are single pane sliders with storm sliders.
- The lighting levels in the resource area should be reduced from 940 lux to 500 lux.
- The lighting levels in the work room should be reduced from 1450 lux to 750 lux.
- There was one fixture with burnt out lamps.
- The room has a distinct smell of fuel oil.

(10) General Office And Principal's Office

- Lighting levels should be reduced from 750 lux to 500 lux.
- One fixture had burnt out lamps.

(11) Classroom Corridor

- The windows are single pane sliders with storm windows.
- The lighting levels range from 640 lux to 120 lux and therefore should not be reduced.
- Four fixtures had burnt out lamps.

(12) Main Entrance Vestibule

- The lighting levels should be reduced from 230 lux to 100 lux.
- One fixture had burnt out lamps.
- Doors need weatherstripping.
- The outside doors do not close properly due to snow building up between the door and the jamb.
- The supply air ducts are plugged with dirt and garbage thus the area is not receiving adequate warm airflow to maintain thermostat settings.

(13) Link Hall And Gym Vestibule

- Windows are single pane sliders with storm window sliders.
- One of the outside storm windows was open about an inch.
- Several fluorescent tubes were in poor condition and need replacing.

(14) Plastics, Electronics And Industrial Arts Lab

- The windows are single pane aluminum frame sliders with storm windows.
- Light levels are adequate.
- Four fixtures had burnt out tubes.
- There is a large garage door which is uninsulated and poorly sealed.
- The thermostat guard has been removed.

(15) Gym And Gym Change Rooms

- Outside doors need weatherstripping.
- The ventilation system is not being used to its optimum, since the principal has not been informed as to the function of the controls.

(16) Stage Storage

- The return air fan for the gym is in the ceiling space of this area and was not on at the time of inspection.
- There are also two controls in this room for operating the gymnasium ventilation systems. One is a "Day/ Night" setting which actually ventilates or recirculates the air. The other switch is a damper adjustment switch which sets the minimum position of the outside air dampers.

(17) North Mechanical Room

- There are four oil fired forced air furnaces with outputs of 97,000 BTU/hr to 71,000 BTU/hr. (Two furnaces are Enterprises and two are Olsons)
- An interview with maintenance personnel for the school revealed that general maintenance on mechanical equipment (eg. filter changed, fan belts checked, heat exchanger cleaned) occurred approximately twice per year.
- The efficiency of two of the furnaces was tested during the inspection and found to be 69% in the older Enterprises and 70% in the newer Olson. This is a poor operating level for oil fired units.
- The fan belts were generally found to be tight, however, the furnace filters were very dirty. Also the filter accesses were not covered.
- A leak in an oil line was found in the crawlspace adjacent to the mechanical room.

(18) Mechanical Room Next To The Principal's Office

- There are three oil fired forced air furnaces (Olsons 97,000 BTU/hr). These furnaces have retention head burners.
- The efficiency of one furnace was tested and found to be 73% which is too low for this type of furnace.
- The furnace filters were very dirty.
- The mechanical room itself was very cold.
- The crawlspace was accessed - this is where the uninsulated supply air ducts run. The temperature of the crawlspace was 19^{0}C with a relative humidity of 55%.

(19) Generator Room

- House the diesel/generator which provides backup power when electricity is out.
- The batteries were corroded and the generator would not start.

(20) Mechanical Room Next To The Gym

- There are seven oil fired forced air furnaces (5 Olsons 97,000 BTU/hr and 2 Olsons 91,000 BTU/hr). These furnaces have retention head burners.
- The efficiency of one furnace was tested and found to be 78%. This is lower than can be achieved with this type of furnace.
- The fan belts were tight but the furnace filters were very dirty.
- At the time of the audit the return air fan for the gymnasium ventilation system was turned off. The control for the fan is in this mechanical room.
- The outside air damper was moving to the open position even though the gym had a very low occupancy rate and the outside temperature was -42^{0}C.
- The industrial arts, plastics, and electronics lab receives 100% fresh air twenty four hours a day. The fresh air damper is manually controlled.

4.4. Stony Rapids School Maintenance Practices and Evaluation

4.4.1 Interview with Maintenance Personnel

The maintenance personnel for Stony Rapids school are located in La Ronge, Saskatchewan. Up until recently the school was only visited once per year for a regular servicing of the furnaces. The school is now visited in the spring and in the fall of each year.

Priority is given to completing furnace maintenance which generally follows the manufacturers recommended servicing guidelines. Once the furnaces are completed, weatherstripping and caulking are next on the priority list. The principal also may have specific areas which need attention and generally provides the maintenance people with a list of these items.

The light bulbs and fluorescent lamps are cared for by the caretaker and the maintenance crew change the ballasts as required.

The maintenance crew do not check or adjust damper positions for the ventilating systems nor do they do any maintenance or cleaning of the duct system.

Recommendations from the maintenance personnel to improve the energy efficiency of the building were:

- Install strong metal thermostat guards which are kept locked so that thermostat settings are controlled only by the principal.

- Clean the furnace filters on a regular basis as only once a heating season is insufficient to maintain good airflow.

4.4.2. Maintenance Schedule

The actual maintenance schedule:

- Complete furnace maintenance to each furnace which includes burner service, and cleaning.

- Structural repairs including weatherstripping and caulking.

- Any specific items which the principal draws to their attention.

- Change light ballasts as required.

The recommended maintenance schedule for furnace service is:

- Inspect and clean heat exchanger.
- Oil blower motor bearings.
- Check belt for wear and tension.
- Replace air filters.
- Inspect and service the burner.
- Replace oil filters.

4.4.3. Audit Team Observations

Exterior Doors: Require weatherstripping
Industrial Arts Garage Door: Requires a weatherstripping kit.
Windows: Windows with wood frames require caulking.

Mechanical: North Mechanical Room

- Furnace # 1
  Draft = 0.04
  CO2 = 7.2
  Temperature: 340^{0}C - (640^{0}F)
  Efficiency = 69%
  Filter very old and dirty
  Belt is tight.

Analysis of this data indicates that the quality of performance is poor for both the furnace and the burner and indicating overfiring or inadequate heat exchange.

- Furnace # 2
  Draft = .18
  CO2 = 6.3
  Temperature: 324°C - (615°F)
  Efficiency = 70%
  Filter is very dirty
  Belt is tight
  Fan motor is squeaky

Analysis of this data indicates that the quality of performance is poor for both the furnace and the burner. This performance is evidence of overfiring or poor heat exchanger design.

- Domestic hot water heater is set at 82°C (180°F)
- Oil line is leaking in crawlspace.
- Filter access was not on furnace # 1 and air is likely being drawn from the mechanical room.

<u>East Mechanical Room</u>

- Furnace Test:
  Draft = 0.04
  CO2 = 6.3
  Temperature = 293°C - (560°F)
  Efficiency= 73%
  Filter is very dirty
  Fan belt satisfactory

Analysis of this data indicates that the quality of performance is typical for the furnace and poor for the burner. In new equipment this is evidence of a poor burner performance. The burner may meed to be adjusted to increase the combustion air.

Mechanical Room Next To The Gym

- Furnace Test
  Draft = 0.08
  CO2 = 8.9
  Temperature = (295^{0}C) - (563^{0}F)
  Efficiency = 78%
  Filters are very dirty

Analysis of this data indicates that the quality of performance is typical for the furnace and burner and is common to new equipment with retention head burners.

Ventilation

Although the blowers and filters are regularly maintained there did not appear to be any provisions for cleaning the duct system. Duct cleaning should be included as a regular maintenance procedure. Many of the supply air registers were clogged - particularly in the main entrance.

It is likely that the system requires air balancing since there was a complaint of over heating and under heating in two of the classrooms. The airflows were measured for both classrooms and did not meet the designed requirements.

The gymnasium ventilation system is not being operated properly as the return air fan for the system is turned off and the mixed air controller and outside air controller are set at incorrect temperatures and the "**day/night**" control and the "**damper/adjustment**" control are incorrectly set.

Also, the industrial arts room is being supplied with 100% outside air all of the time. The outside air damper is manually adjusted and is in the full open position. When the room is being used and toxic fumes are being produced 100% fresh air is essential. However, this is only a small percentage of the time - automatic controls should be considered.

Electrical

The lighting system was in fair condition although poorly maintained having several lamps burnt out.

4.4.4 Recommendations

Stony Rapids school receives just enough maintenance to keep "things" going until the next season. Unfortunately this seemingly "low" cost maintenance plan has hidden costs which include higher than necessary fuel bills and a shorter useful life for equipment. Fortunately when the maintenance crew visit the school each furnace is thoroughly serviced. There are, however, a number of measures that can be implemented to improve furnace efficiencies and minimize maintenance:

- Weatherstrip all doors.
- Install a weatherstrip kit on the garage door of the Industrial Arts room.
- Replace all windows having wood frames with thermally efficient double pane windows.
- Lower temperature of domestic hot water heater to $55^{0}C$ ($130^{0}F$).
- Install high-velocity -low volume shower heads.
- Ensure that furnace filter accesses are on or tightly closed.
- Ensure the fan belts, furnace filters and oil filters are in good condition and that replacements are on hand.
- Instruct caretaker to vacuum furnace filters once a month and to vacuum supply air registers.
- Check oil lines for leaks.
- Replace all old furnace burners with retention head burners as this will increase the furnace efficiency.
- Install a delayed action solenoid valve on every furnace burner as this will promote cleaner combustion and thus reduce maintenance.

- Instruct maintenance crew on the proper care and operation of the ventilating systems. The temperature on mixed air controller for the gymnasium should be set at 20°C (68°F) and outside air controller at 23 °C (74°F).
- Install a motorized control on outside air damper for industrial arts room.
- Relamp with long life low-wattage Vita-lite tubes. This will save electricity and minimize caretaking.
- Install thermostat guards on all thermostat controls.

The furnace in the North mechanical room is one of the original furnaces installed when the school was first constructed in the 1960s. There are four such furnaces and all of them are probably operating at or near the same efficiency as the furnace tested. By replacing the old furnaces with new furnaces having retention head burners the combustion efficiency will be increased significantly .

Two of the furnaces in the North mechanical room were installed in 1975 and have a higher efficiency than the older models but are not up to energy efficient standards. By retrofitting the burners with a retention head burner kit and installing a delayed action solenoid, these furnaces will become far more efficient.

The furnaces next to the gym and the principals office all have retention head burners as they were installed in 1979. It is likely that the efficiencies would be higher if the furnace filters were clean. Also by installing a delayed action solenoid valve efficiency could be improved.

Delayed action solenoids valves fit between the burner nozzle and the oil supply pump. Its function is to reduce the introduction of unburned or partially burned oil into the combustion chamber at the beginning and end of each heating cycle and, therefore, increase efficiency by:

- Reducing the amount of soot produced by the burner flame, therefore keeping the heat exchanger cleaner for a longer period.

- Extending the efficient operating life of the nozzle by preventing clogging from unburned residues.

- Allowing the furnace to run cleanly with less excess combustion air.

The other area for concern is the ventilating systems. Discussions with the maintenance personnel and principal indicated that neither felt knowledgeable enough in regards to the ventilating systems to maintain or operate them. Unfortunately the gym ventilating system is not operating as it should be:

- The return air fan for the gymnasium has been switched "off".

- The gym has a ventilation control which can be set to recirculate air ("night" setting) or to mix outside and return air ("day" setting). However, no one seemed to be aware of what this switch does. It is also located in the storage room by the stage which would indicate that it can be turned from one setting to the other at the whim of all occupants.

- Next to this "day/night" control is a control which allows the operator to adjust the minimum position of the outside air dampers. Once again the operators were not aware of the function of this control.

- The temperatures for the mixed air controller and outside air controller for the same ventilation system are both set at (5^0F) rather than 55^0F and 74^0F respectively.

Also the ventilation system for the industrial arts room is supplying far more fresh air than is necessary. The reason for this is related to the outside air damper which is manually

operated. When the exhaust air fans are operating in the industrial arts room, it is necessary for the exhausted air to be "made up" with outside air however it is not necessary for outside air to be provided 100% of the time. A motorized control which would open the outside air damper when the exhaust air fans are turned on in the industrial arts room should satisfy ventilation requirements.

By simply informing the maintenance crew and the principal of how these two ventilating systems should operate will save energy and improve comfort. The other recommendations should help to improve the energy systems efficiencies as well as reduce maintenance requirements to a manageable level.

4.5. Stony Rapids School Opportunities For Energy Conservation

4.5.1 Energy Conservation Through School Operations

Stony Rapids school is the largest school of the three audited. It is occupied during the day with students from kindergarten to grade nine, four teachers and a principal. In the evening the gymnasium and industrial arts rooms are used by the community. There are a number of ways to conserve energy by simply modifying the operation of the building. The modifications involve all the occupants and fortunately will not take much extra time or training. The following suggestions are broken down into groups of people who will most likely be responsible or have input into the energy conserving measure:

Principal, Caretakers and Students:

- Turn lights, fans and taps off when they are not required. Any dripping hot water taps should be noted so that the maintenance staff can repair the faucet.

- Close the drapes or window coverings after class as this will reduce heat loss through the windows during unoccupied hours. Also on extremely cold days closing the drapes will reduce drafts.

Principal:

- For occupied areas set thermostats at $20^{0}C$ and $15^{0}C$ for unoccupied areas (also hallways). Each degree the thermostat is turned back results in a 3% reduction in fuel consumption (ASHRAE 1981)

- Keep the maintenance personnel posted as to condition of the weatherstripping and window caulking as well as light bulbs and furnace filter supply.

- Make sure furnace filter accesses are kept on or closed.

- Set the controls for the gymnasium ventilation as follows:

  Return air fan "**ON**" (control is in the mechanical room next to the gym).

  "Day/Night" Control set on "**NIGHT**".

  Damper adjustment knob at "**MINIMUM**" position.

If more ventilation is required at any specific time increase damper position and/or set "day/night" control on "day". Remember to return to original settings.

Caretaker:

- Vacuum furnace filters once a month.
- Make sure furnace filter accesses are closed.
- Check and vacuum supply air registers and specifically the supply air registers in the main entrance.

4.5.2 Energy Conservation Through School Maintenance

The present maintenance schedule should be adhered to with a minimum of two visits per year. The following measures should be implemented by the maintenance crew:

- Weatherstrip all doors.
- Install a weatherstrip kit on the garage door of the industrial arts room.
- Start regular servicing of the domestic hot water heater.
- Lower the temperature of the domestic hot water heater to $55^{0}C$ ($130^{0}F$).

- Install high-velocity - low volume shower heads (See Appendix E for manufacturers literature)
- Ensure that fan belts, furnace filters and oil filters are in good condition.
- Become familiar with the correct operation of the ventilation system.
- Set temperature on mixed air controller for the gymnasium at $20^{0}C$ ($68^{0}F$) and outside air controller at $23^{0}C$ ($74^{0}F$).
- Vacuum supply air ducts.
- Install thermostat guards on all accessible controls.
- Install delayed action solenoids valves on all furnaces.

By implementing the above recommendations the school energy systems will operate more efficiently. The measures will either improve control, for instance with thermostat guards, or minimize waste in the case of lower hot water temperatures.

4.6. Measures That Will Contribute To Energy Conservation

4.6.1 Introduction

There are a number of measures that will contribute to energy conservation for Stony Rapids school. These include:

- Installing night setback thermostats with thermostat guards.
- Improving window systems.
- Installing delayed action solenoid valves on furnaces.
- Retrofitting or replacing furnaces having standard burners with retention head burners.
- Installing a motorized control on the outside air damper for the industrial arts ventilating system.
- Reducing excess light by removing excess light fixtures.
- Using low-wattage long life fluorescents.

All of the above measures have a simple payback of less than five years and most can be achieved by the school board maintenance personnel. Reinsulating was not considered a viable option as the high capital cost of adding more insulation cannot be justified by the moderate energy savings at this time.

4.6.2 Night Setback Thermostat

Night setback thermostats include a timer which allows for temperature settings at different times and replaces the regular thermostats. In this way, the temperature can automatically be setback after occupancy and then automatically warmed up before students arrive in the morning.

Implementing this measure is relatively straight forward as the school board maintenance personnel should be able to install the thermostats during a routine maintenance visit. The thermostats costs approximately $80.00 each and Stony Rapids school requires ten for a total cost of $800.00

Significant savings can be achieved from setback temperatures as it has been estimated that a 3% savings may be achieved per degree the thermostat is turned back. The school is unoccupied for approximately 108 hours per week and the temperature may be kept at 15^{0}C (60^{0}F) during this time. The estimated fuel saving could be as high as 14,080 litres or $6,450.00 for one year. This savings yields a payback time of one and half months.

4.6.3 Improving The Window System

Presently there are two windows systems in the Stony Rapids school. The first is in the original school and are single panes of glass in wood frames. The caulking that seals the glass to frame has dried up and in many instances has fallen off thus leaving the glass to literally "rattle" in the frames. The second system is a single pane window in aluminum frames with a single pane window in aluminum frame storm window.

In comparison with the first or original windows the second system is more energy efficient and requires less maintenance (no caulking required). However, considering the severity of the local climate and the duration of winter this type of window system is barely adequate.

Replacing the single pane windows with double pane windows in thermally efficient frames will yield savings of 900 L or $412. per year. The capital investment would be approximately $1,300.00 for a payback time of 3 years. To replace all the windows the cost would be approximately $7,000.00 for a savings of $1,450.00 per year. The payback time would be just under five years.

4.6.4 Installing a Delayed Action Solenoid Valve on Furnaces

A delayed action solenoid valve is installed between the burner nozzle and oil supply pump. On furnace start up it delays the "on" flow of oil to the nozzle for a few seconds allowing the combustion air fan to reach full speed and the oil pump to reach its full operating pressure. On "shut down" the valve closes instantly, preventing additional oil from leaving the nozzle. In this way unburned or partially burned oil is prevented from entering the combustion chamber at the beginning and end of each heating cycle thus increasing efficiency.

This device extends the operating life of the nozzle by preventing clogging with unburned residues. Also the furnace will run cleanly with less access combustion air and reduced amounts of soot which in turn keeps the heat exchanger cleaner.

The amount of energy saved by this device is difficult to estimate. However the device does raise the efficiency of the furnace without requiring additional annual maintenance which is an advantage for this remotely located school. The cost for a delayed action solenoid is about $51.00 Thus to install them on all sixteen furnaces would cost $820.00. To pay for themselves in the first year would require seasonal efficiency to improve by about 2%.

4.6.5. Retrofitting Or Replacing Furnaces Having Standard Burners With Retention Head Burners.

The retention head burner is designed to provide a turbulent flow of combustion air to mix with the fuel oil. In this way a superior air to oil mix is produced so that fuel burns more efficiently. Since the fuel is burning more completely higher temperatures are produced making it necessary to downsize the burner nozzle and install a ceramic fibre liner to protect the combustion chamber.

There are three options to this measure. They are:

- **To retrofit existing burners** providing the burner is compatible with the retrofit kit and is not in such a deteriorated condition that alteration to only one component is not justifiable.

- **To replace the existing burners** with a retention head burner considering that the new burner will be guaranteed and should function reliably for the duration of the life of the furnace.

- **To replace the existing furnace** with a new furnace complete with a retention head burner.

Each will depend on a careful evaluation of the furnaces at Stony Rapids school. Presently there are sixteen furnaces:

- Four were installed in the original school built in the 1960s , two are located next to the science room while the other two are in the North mechanical room.. These furnaces are about twenty years old.

- Two were installed in 1975 and are located in the North mechanical room. These furnaces are about ten years old.

- Ten were installed in 1979 and are located in two mechanical rooms - one next to the principals office and the other next to the gym. These furnaces are about five years old and have retention head burners.

Therefore, there are six furnaces that should be upgraded. The four older furnaces will probably have to be replaced completely or at least have the burners replaced. The two furnaces installed in 1975 may be suitable for a kit providing the burner is in good shape and is compatible to the retrofit.

The economic evaluations were computed assuming the worst case: four new furnaces with retention head burners and two new retention head burners including combustion chamber ceramic liners. The total installed cost was estimated to be $9,300.00 The savings were approximated assuming a 10% increase in seasonal efficiency for the furnaces resulting in a dollar savings of $1,900.00 per year. The payback time on this investment is 4.9 years.

4.6.6 Installing a Motorized Control On The Outside Air Damper For The Industrial Arts Ventilation System

The present ventilation system for the industrial arts area incorporates a manual damper to control the amount of outside air that is allowed into the system. This damper is set in the full open position allowing 570 L/s (1200 cfm) of extremely cold air into the air supply all winter.

Since the outside air is only required when the exhaust fans in the industrial arts room are turned on a motorized control could shut the dampers when the outside air is not required. Turning on any of the exhaust fans would simultaneously energize the damper motor and open the dampers.

To calculate savings it was assumed that fresh air would be required 35 hours/week. Therefore the dampers would be closed for 133 hours per week. This would mean a yearly savings of $3,000.00.

The cost to install the motorized dampers and modulating motor would be approximately $960.00. The payback time then is about four months.

TABLE 4.7

ESTIMATED ELECTRICAL CONSUMPTION OF PRESENT LIGHTING SYSTEM

Location	#of Fixtures	#of Lamps	Wattage	Wattage Including Ballast	H/D Hours/ Day	D/Y Days/ Year	Annual Consumption kWh/yr
North Entrance	2	2 X	F40 =	180	14	200	504
Staff room	2	2 X	F40 =	180	7	200	252
Boys Washroom	3	2 X	F40 =	270	7	200	378
Girls Washroom	5	2 X	F40 =	450	7	200	630
Classrooms	144	2 X	F40 =	12,960	14	200	36,288
Hallway	17	2 X	F40 =	1,530	14	200	4,284
Resource Centre.	30	2 X	F40 =	2,700	7	200	3,780
General Office	5	2 X	F40 =	450	7	200	630
Principal's Office	5	2 X	F40 =	450	7	200	630
Link	14	2 X	F40 =	1260	14	200	3528
Gym	33	1 X	MV400 =	13,200	10	200	26,400
Storage	3	2 X	F40 =	270	7	200	378
Change Rooms	10	2 X	F40 =	900	7	200	1260
Industrial Arts	48	2 X	F40 =	4320	14	200	12,100
Office	3	2 X	F40 =	270	7	200	378
Plastics and Electronics	10	2 X	F40 =	900	14	200	2,520
TOTAL							93,940 kWh/yr

F40 - Fluorescent 40 Watt Tube
MV400 - Mercury Vapour 400 Watt Lamp

4.6.7 Removing Excess Lights

In general, Stony Rapids school has more than adequate lighting levels for proper visual contrasts. The light levels were measured in each classroom and were on the average 30% above recommended levels. However, each classroom had two or more fixtures with burnt out fluorescents or partially blackened fluorescents. Therefore, the light levels would be higher if all the lamps were working.

Present electrical consumption for lighting is estimated in Figure 4.7 showing a yearly total of 93,940 kWh costing $35,700 at $.38/kWh. By reducing light levels - which means removing fluorescent tubes and ballasts - in the classrooms, resource centre and plastics lab 8,500 kWh or $3,240.00 may be saved. It is likely that additional savings may be achieved by accurately measuring light levels when all fluorescents are working.

To implement a delamping project is relatively straight forward and could be accomplished using the school board maintenance staff. It would be necessary to measure the light levels before and after lamp removal to ensure that there will be adequate light levels. This may require hiring a light maintenance contractor which could cost up to $1,500.00.

Conversations with lighting maintenance contractor Richard Parker of Luminaire Specialty Ltd. of Regina indicated that costs may indeed be minimized by having the principals or maintenance personnel read the light levels. He thought that the project could be accomplished by using the electrical plans to identify key areas to measure light readings for the maintenance person. Then the floor plans and a light meter would be sent to the school so that the appropriate measurements may be taken. Once this is done the readings would then be analyzed and delamping action recommended.

The approximate payback is six months based on $3,200 per year savings and $1,500 capital cost.

4.6.8 Using Low-Wattage Fluorescent Tubes

There are fluorescent lamps available which have improved efficiencies by emitting more light per watt than regular fluorescents. Hence a lower-wattage is required for virtually the same light levels. By relamping with lower-wattage fluorescents energy costs can be reduced by 14% with a light loss of less than 10%.

Apparently some low-wattage tubes do not last as long as regular fluorescents. This varies with manufacture, however there are low-wattage tubes available with a rated life of 24,000 operating hours which the manufacturers guarantee for 2 1/2 years. These tubes are more expensive than the competitors, but with the energy saved they pay for themselves in 2.2 years.

The estimated electrical savings that will result from relamping with lower-wattage tubes is approximately 10,100 kWh per year for a dollar savings of $3,840.00 per year. There are 610 fluorescent tubes to replace which costs approximately $1,400.00 for most low-wattage tubes and $7,300.00 for the guaranteed tubes.

If the guaranteed tubes do indeed last significantly longer, costs of shipping and caretaking will also be reduced.

FIGURE 4.8

SUMMARY OF MEASURES THAT WILL CONTRIBUTE TO ENERGY CONSERVATION

Option	Annual Requirement (Litres)	Annual Fuel Costs ($0.458/L)	Capital Cost of Option	Lifecycle Cost Of Fuel Over 15 Years	Net Savings Over 15 Years
FUEL/OIL					
No Energy Retrofit	98,200	$44,975.00	Nil	$546,890	Nil
Night Set-back Thermostats	84,120	$38,527.00	$ 800.00	$468,482	$77,600.00
Improving the Window System	95,030	$43,524.00	$7,000.00	$529,247	$10,640.00
Delayed action Solenoids					
Retention Head Burners & Delayed Action Solenoids	94,050	$43,075.00	$9,300.00	$523,790	$13,800.00
Motorized Damper Control	91,610	$41,960.00	$ 960.00	$510,210	$35,720.00

NOTE: 1. Numbers may not add due to rounding

2. Savings are not additive since savings are calculated on the basis of a single change to the present system. Therefore, as measures are implemented the potential savings from the remaining measures is diminished.

FIGURE 4.8 (Continued)

SUMMARY OF MEASURES THAT WILL CONTRIBUTE TO ENERGY CONSERVATION

Option	Annual Fuel Requirement (kWh)	Annual Fuel Costs ($0.38/kWh)	Capital Cost Of Option	Lifecycle Cost Of Fuel Over 15 Years	Net Savings Over 15 Years
ELECTRICAL					
No Energy Retrofit	117,000	$44,460.00	Nil	$540,626	Nil
Delamping (Removing Excess Lights)	108,500	$41,230	$1,500.00	$501,350	$37,775.00
Relamping (Using Low Wattage Tubes)	106,900	$40,620	$1,400.00 (initially) $14,000.00 (over 15 yrs)	$493,930	$32,700.00
Relamping Using Guaranteed Low-wattage Tubes	106,900	$40,620	$7,300.00 (initially) $14,600.00 (over 15 yrs.)	$493,930	$32,090.00

NOTE: 1. Numbers may not add due to rounding

2. Savings are not additive since savings are calculated on the basis of a single change to the present system. Therefore, as measures are implemented the potential savings from the remaining measures is diminished.

4.7. Energy Implementation Plan

4.7.1 Implementation With No Capital Investment And Immediate Savings

Maintenance:

- Install an oil fuel line meter (requires capital investment).
- Lower temperature of hot water heat to 55°C (130°F).
- Ensure that furnace filter accesses are on and tightly closed.
- Repair oil line leak.
- Set temperature on mixed air controller for gymnasium ventilation system at 20°C (68°F). Also set temperature on outside air controller at 23°C (74°F).
- Service and clean furnaces and burners.

Operations - Principal, Students and Caretakers.

- Start monitoring monthly fuel consumption.
- For occupied areas set thermostats at 20°C and for hallways and unoccupied areas set at 15°C.
- Set gymnasium ventilation controls as follows:

  Return air fan on "Day/Night" control on "**Night**" and "Damper Adjustment" knob on "**Minimum**".
- Close drapes or window coverings after class.
- Vacuum furnace filters once a month.
- Make sure furnace filter accesses are closed.
- Vacuum supply air registers.

4.7.2 Measures Requiring Capital Investment

Maintenance:

- Weatherstrip doors and caulk windows for a cost of approximately $120.00 per year.
- Install delayed action solenoid valves on all furnace burners costing approximately $800.00.
- Install thermostat guards on all thermostats.

4.7.3 Capital Cost Measures

- Install night setback thermostats for a payback of 1 1/2 months.
- Install efficient shower heads which reduce the hot water requirement by 50%. Savings may be $1,100.00 per year. Payback time is 2 months.
- Install a motorized damper control on the outside air damper of the industrial arts ventilation system for a payback of 4 months.
- Install delayed action solenoids on furnace burners to reduce maintenance requirements and improve furnace efficiencies.
- Install retention head burners on furnace with standard burners for a payback of 4.9 years.
- Retrofit windows by replacing single pane windows in wood frames with double panes for a payback of 3 years.
- Retrofit all windows by replacing with double pane windows for a 5 year payback.
- Remove excess lighting and thereby reduce electrical consumption by 8%. The payback is approximately 6 months.

- Relamp with low-wattage fluorescents reducing electrical consumption by 12%. The payback is approximately 2 years.

4.7.4. Summary of Measures

The fuel savings resulting from the above recommendations are supported by economic analysis. However, some measures cannot be realistically calculated such as the effect of regularly cleaning the furnace filters. While accurate calculations of savings is not possible these type of initiatives are equally important. Also, the savings are not additive due to the law of diminishing returns; as each measure is implemented the potential savings from remaining measures is reduced.

All calculations of savings are based on fuel costs of $.458/L for fuel oil and $0.38/kWh for electricity.

4.8. Implementation Timetable

When to initiate the above energy conserving measures can be a critical decision. And deciding not to implement any of the recommendations or even delaying by half a heating season, will result in a waste of energy and money.

The following checklist is a sequence for implementing energy conserving options at Stony Rapids. The first measures are the "no cost" recommendations which are simply related to building operation and maintenance. This is followed by low cost options which offer large savings and quick paybacks. While the final section lists options that require a greater capital investment.

If the school is going to implement an energy conservation program it is essential that a fuel line meter is installed at the outset. Then energy conserving initiatives can be monitored to ensure that the expected savings are being achieved.

Implementation Timetable

Immediate:

- Install an oil fuel line meter.
- Meter monthly consumption using the monitoring procedures outlined in the following chapter.
- Lower temperature of hot water heater to $55^{0}C$ ($130^{0}F$).
- Ensure that the furnace filter accesses are on and tightly closed.
- Repair oil line leak.
- Set temperature on mixed air controller for the gymnasium ventilation system at $20^{0}C$ ($68^{0}F$). Also set temperature on outside air controller at $23^{0}C$ ($74^{0}F$).
- Service and clean furnaces and burners.
- Set thermostats at $20^{0}C$ for occupied areas and for $15^{0}C$ for unoccupied areas.
- Adjust gymnasium ventilation controls as follows:

  Return air fan on "Day/Night" control on "**night**" and "Damper Adjustment" knob on "**Minimum**".
- Close drapes and window coverings after class.
- Vacuum furnace filters once a month.
- Vacuum supply air registers.

Before the next heating season:

- Install night setback thermostats.
- Install high-velocity - low volume shower heads.
- Install thermostat guards on all thermostats.
- Install delayed action solenoids valves on furnace burners.
- Install a motorized damper control on the industrial arts room outside ventilation system.
- Weatherstrip doors and caulk windows.
- Remove excess lighting.

As soon as economically feasible:

- Retrofit windows by replacing just the single pane in wood frame windows with double pane windows.
- Retrofit all windows by installing double pane windows and leaving in storm windows.
- Retrofit or replace standard furnace burners with retention head burners.
- Relamp with low-wattage fluorescents.

4.9. The Energy Budget

4.9.1 General

The true effect of an energy conservation program can only be measured if past and current fuel consumption is accurately documented. This section presents a historical perspective on

Stony Rapids school fuel use. Based on this historical data an energy budget of current energy consumption was developed. The budget provides a measuring stick for conservation initiatives and reflects energy use before any changes take place.

The final portions of this section present a method to monitor and document energy use so that the success of a conservation plan can be evaluated on an annual basis. This method allows an accurate comparison of fuel bills by adjusting portions of the energy use to actual climatic factors (degree days). The approach is relatively simple and could be used by the school principal or some other member of the school board. This approach also forms a very good foundation for an energy conservation incentive program.

4.9.2 Historical Energy Consumption

Figures 4.9 and 4.10 presents electrical and fuel oil bills for the school from January 1982 to September 1984 inclusive. In addition Figure 4.11 presents a graphical presentation of monthly electrical use over the same period of time. Since only periodic oil bills are available a similar graphical representation of fuel bills is not possible.

The absence of a monthly fuel oil consumption record provided some limitations in developing an accurate energy budget. It is highly recommended that the school board invest in a fuel consumption meter that would allow regular monitoring of fuel oil use on a monthly basis.

The yearly fluctuation of energy consumption is likely a result of differences in severity of the winters. That is 1983 was a milder winter than 1982.

FIGURE 4.9

ELECTRICAL BILLS FOR 1982, 1983 and 1984 STONY RAPIDS

Month	KWH	1982 Cost $	KWH	1983 Cost $	KWH	1984 Cost $
Jan	8,400	2,910.60	12,320	4,268.88	10,160	4,053.84
Feb.	11,840	4,102.56	11,440	3,963.96	12,880	5,139.12
Mar.	10,640	3,686.76	11,680	4,047.12	9,680	3,862.32
Apr.	10,160	3,520.44	9,680	3,354.12	9,680	3,862.32
May	9,920	3,437.28	8,480	2,938.32	8,240	3,287.76
June	9,040	3,132.36	9,680	3,354.12	7,280	2,904.72
July	8,160	2,827.44	5,040	2,010.96	7,360	2,936.64
Aug.	4,880	1,690.92	4,800	1,915.20	4,720	1,895.67
Sept.	7,680	2,661.12	10,386	2,174.44	5,040	2,063.88
Oct.	12,480	4,324.32	10,720	4,277.28		
Nov.	12,800	4,435.20	9,520	3,798.48		
Dec.	11,600	4,019.40	9,120	3,638.88		
TOT.	117,600	$40,748.40	112,866	$39,741.76	75,040	$30,006.27

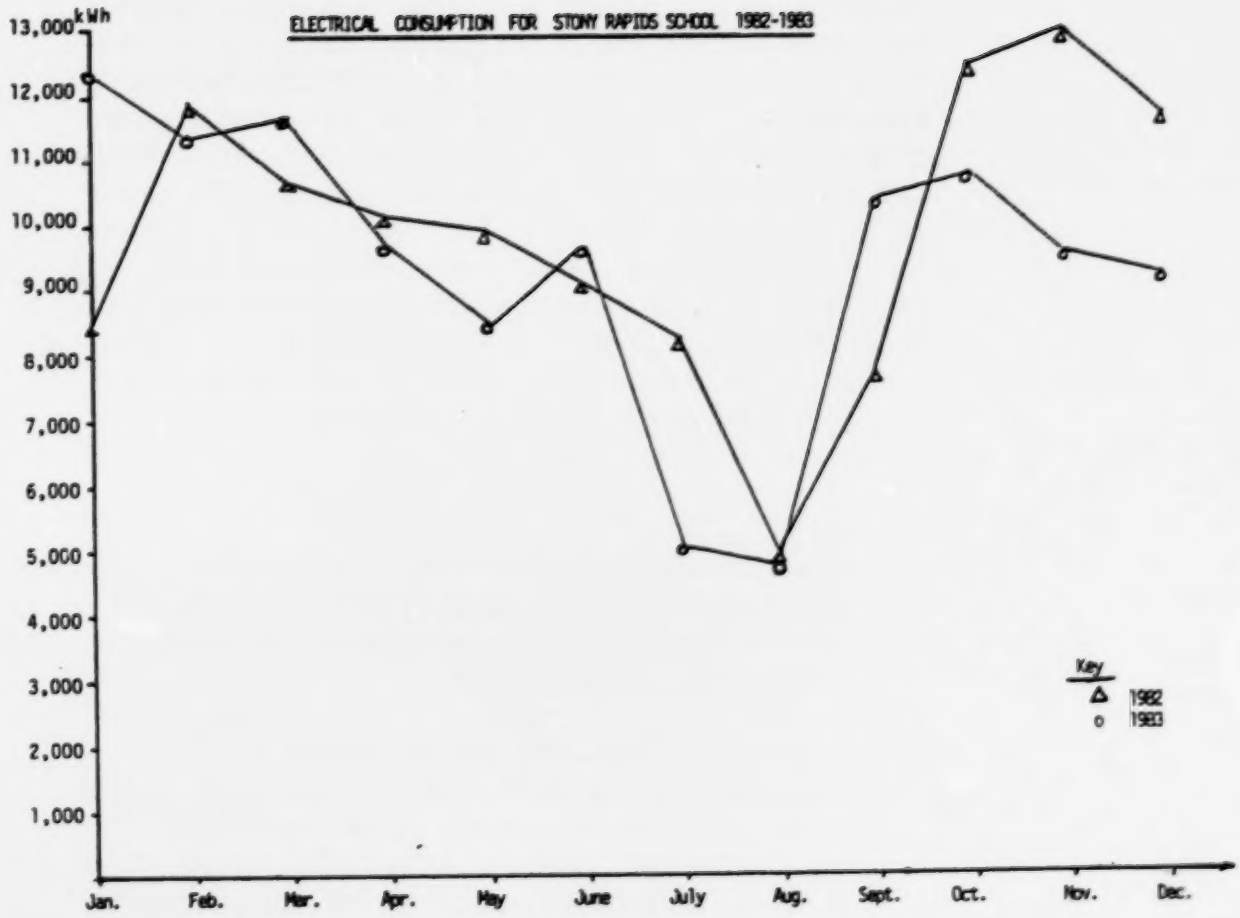
Figure 4.10

FUEL OIL BILLS FOR 1982, 1983 and 1984 STONY RAPIDS

Month	Litres	1982 Cost $	Litres	1983 Cost $	Litres	1984 Cost $
Jan.	15,587	5,360.15			19,888	8,610.50
Feb.	11,932	4,248.99	39,693	14,539.55	8,101	3,508.17
Mar.	5,456	1,971.26	3,674	1,459.68	5,872	2,542.58
Apr.	5,020	1,813.73	9,369	3,738.88		
May						
June	44,820	16,478.54	2,009	802.19		
July					1,927	921.11
Aug.			17,378	7,003.33	690	278.07
Sept.			1,587	639.56		
Oct.			3,166	1,275.90		
Nov.	19,252	7,379.29	8,390	3,381.17		
Dec.			9,079	3,658.97		
Tot.	102,057	$29,872.67	94,345	$36,499.15	36,479	$15,860.43

FIGURE 4.11

GRAPH OF ELECTRICAL USE



4.9.3 Monitoring Fuel Oil Consumption

It is very important that the fuel consumption is measured and recorded on a monthly basis. Electrical bills show the monthly consumption, however, to monitor the heating fuel a meter will have to be installed.

Monitoring information will also sustain participants interest and, thereby, enthusiasm in the energy conservation program. It will be necessary for the principal to record the monthly consumption to make calculations to see if a savings has been achieved. This will involve comparing the theoretical consumption which is based on outside temperatures with the actual consumption. Figures 4.13 and 4.15 are sample forms for achieving this end. All fuel consumption figures are adjusted using monthly weather data for Uranium City from Environment Canada Climatic Services Branch. In this way fuel savings will be evident even if winter temperatures are "mild". The fuel oil energy monitoring chart is fairly easy to use and involves the following steps.

- Phone Environment Canada Climatic Services Department obtain the actual degree days for the months. **Record degree days on the electric and fuel oil charts (see figure 4.13 and 4.15)**

- Calculate the theoretical fuel consumption by multiplying degree days by the constant k (see figure 4.12). The constant k is unique for each building and reflects the heat loss characteristics and furnace efficiencies. **Record theoretical fuel consumption on the chart.**

- **Record actual fuel consumption** from fuel line meter.

- Savings is obtained by **subtracting the actual fuel consumption from the theoretical fuel consumption.** A positive number indicates a fuel savings. A large negative number (more than 10% increase) should be cause for evaluating the energy system to find the reason for the increase. Some possible reasons for an increase are: fuel line leaks, dirty furnace filters, dramatic change in building use.

The additional information on the chart is:

- Normal heating degree days from Environment Canada which are 30 year averages and

- Estimated fuel consumption calculated using the normal degree days and the constant "k".

This information is provided for comparison only and all savings calculations should be based on the actual weather data.

FIGURE 4.12

CALCULATING MONTHLY THEORETICAL CONSUMPTION

HEATING LOAD - STONY RAPIDS

1. Month: _____

2. Actual degree days for month: _____
   (from Environment Canada Climatic Services).

3[1] Oil furnaces

_____Degree Days X 11.7 L/Degree Days _____ litres * 2 fuel oil

The theoretical consumption = _____ litres

or _____ litres X 4.5 litre/gal = _____gallons

Note:

[1] The constant 11.7 L/DEGREE DAYS is derived from the heat loss characteristics of the school, the estimated seasonal efficiency of the heating systems and the heating value of fuel oil.

FIGURE 4.13

ENERGY MONITORING CHART FOR FUEL OIL FOR STONY RAPIDS SCHOOL

Month	1 Normal Heating Degree Days	2 Estimated Fuel Consumption (Litres)	3 Actual Heating Degree Days	4 Theoretical Fuel Consumption (Litres)	5 Actual Fuel Consumption (Litres)	6 Savings -- If Any (Litres)	7 Remarks
January	1,394.6	16,317					
February	1,139.9	13,337					
March	1,041.9	12,190					
April	630.9	7,382					
May	348.8	4,081					
June	142.3	1,665					
July	73.9	865					
August	115.8	1,355					
September	320.5	3,750					
October	536.9	6,282					
November	883.7	10,339					
December	1,231.1	14,404					
TOTAL	7,860.3	91,967					

1. Normal heating degree days are thirty year Environment Canada Climatic Services.
   Estimated fuel consumption is derived my 11.7 L/Degree Day which is an estimated constant based on heat loss characteristics of the school, seasonal efficiency of the heating system and the heating value of the fuel.
3. Actual heating degree days from Uranium City Climatic Services.
4. Theoretical fuel consumption is obtained from multiplying : (Actual heating Degree Days X 11.7 L/Degree Day).
5. Actual fuel consumption is read from the fuel oil line meter.
6. Savings is calculated by: (Theoretical consumption - actual consumption).
7. Remarks: Should record the date of any energy conserving implementations and/or any comments regarding consumption or savings.

4.9.4 Monitoring Electrical Consumption

Electrical consumption can be divided into three components.

- Lighting which is the main component of the monthly electrical bill. The amount of electricity used depends on the hours the lights are turned on.

- Furnace pumps and fans which use electricity depending on the requirement for heat. Presumably the electricity consumed will increase as the outside temperatures decrease.

- Therefore, to estimate a base electrical consumption for the school, the hours the lights were operated was assumed to be approximately 14 hours per week day for the school year from October to May. For the months of June and September the assumption was 8 hours per week day and for July and August 5 hours per week day. The electrical consumption due to the furnace fan and pumps was estimated using a calculation from ASHRAE FUNDAMENTALS 1981 which is based on fuel oil consumption.

The base number does not take into account the consumption designated as "other" since it is such a small component and is difficult to estimate with any accuracy. However, the base number is to be used for comparison only. Once a monitoring program is in place the principal will be able to calculate the theoretical lighting furnace components by using the method shown in Figure 4.14 and 4.15. The theoretical numbers calculated should be very close to the actual consumption of the present systems.

Once energy conserving measures are implemented the actual consumption should drop below the theoretical consumption. For instance if the low-wattage tubes are installed actual consumption should be reduced by approximately 10%. If night setback thermostats are installed there should be an electrical savings since the furnace will be operating less after hours (therefore fans and pumps will be operated less).

The electrical energy monitoring chart is very easy to use and requires the following steps:

- Calculate the estimated electrical consumption due to furnace fans and pumps. This is Step 1 of Figure 4.14.

- Estimate the electricity consumed due to the lights. This is Step 2 of Figure 4.14.

- Add the answers for Step 1 and Step 2 to obtain the total estimated electrical consumption. This is Step 3 of Figure 4.14.

- Then record data on the electrical monitoring chart (Figure 4.15). Column 3 is for actual heating degree days. Column 4 is for hours per billing period the lights were on, Column 5 is for the estimated consumption (the answer to Step 3), Column 5 is for recording the actual consumption and Column 7 is the difference between the estimated consumption and actual and should indicate kWh saved. Column 8 is for remarks or comments.

FIGURE 4.14

BILLING PERIOD: _____

SCHOOL: STONY RAPIDS SCHOOL

ESTIMATING ELECTRICAL CONSUMPTION

STEP 1: Estimate of electricity due to furnace fans and pumps

1. Actual degree days _____

(From Environment Canada Climatic Services)

1.1[1] Electricity Used

_____ degree days X 2.7 kWh/degree day = _____kWh

STEP 2: Estimate of electricity due to lights

Lights on for _____ hours per day

Lights used for _____ days during billing period

Hours lights were on during billing period:

_____ hours/day X _____ days/billing period=

_____hours/billing period.

2.1[2] Electricity Used

_____ hours/billing period X 33.55 kWh/hour= _____ kWh

STEP 3: Total estimate

3.1 Electricity Used

_____ (1.1) electricity + _____(2.1) electricity = _____kWh

(pumps and fans) (lights)

Note:

1 The constant 2.5 kWh/degree day is based on fuel oil consumption since the fans and pumps operate in conjunction with the heating system.

2 The constant 33.55 kWh /hour is the average draw of the lighting system.

FIGURE 4.15

ELECTRICAL MONITORING CHART FOR STONY RAPIDS SCHOOL

Month	Base Estimate kWh	Actual Heating Degree Days	Hours/ Lights On	Theoretical Consumption kWh	Actual Consumption kWh	Savings kWh	Remarks
January	12,490						
February	11,800						
March	11,540						
April	10,430						
May	9,670						
June	7,760						
July	3,550						
August	3,670						
September	8,250						
October	10,170						
November	11,110						
December	12,050						
TOTAL	112,490						

1. Base estimate is for comparison only do not use for calculating savings.
2. Actual heating degree days may be obtained from Uranium City Climatic Services Office.
3. Hours/lights on - is the number of hours the majority of the lights are on per billing period.
4. Theoretical consumption is obtained from the following calculation which is (2.7 kWh X actual Degree Day) + (33.55 kWh/hour X lights on).
5. Actual consumption from meter reading.
6. Savings is calculated by theoretical consumption - actual consumption a positive answer is the kWh savings.
7. Remarks should record the dates of any energy conserving implementations and any comments regarding consumption or savings.

4.10 The Budget

Figure 4.16 presents an energy budget developed by the audit team for the Stony Rapids school. The budget represents energy consumption at the school before any conservation initiatives are taken. Based on the budget conservation goals can be set. Depending on the conservation initiatives adopted a good general goal for the first year of a conservation program is 15-30%

Energy consumed in future years can be measured against the energy budget and the actual percentage savings on a yearly basis can be calculated. The method presented in the previous pages allows for accurate comparison of year to year fuel bills by adjusting consumption figures to take into account climatic variations (eg. unusually warm or mild winter months).

FIGURE 4.16

ESTIMATED ENERGY CONSUMPTION AND COSTS

WITHOUT IMPLEMENTING ANY OF THE CONSERVATION MEASURES

Month	Estimated Consumption (Litres)	Cost ($0.458/Litre) $	Estimated Electrical Consumption (kWh)	Cost ($0.38/kWh) $
January	16,317	7,473.00	12,490	4,746.00
February	13,337	6,120.00	11,800	4,484.00
March	12,190	5,583.00	11,540	4,385.00
April	7,382	3,381.00	10,430	3,963.00
May	4,081	1,869.00	9,670	3,675.00
June	1,665	763.00	7,760	2,949.00
July	865	396.00	3,550	1,349.00
August	1,355	621.00	3,670	1,395.00
September	3,750	1,718.00	8,250	3,135.00
October	6,282	2,877.00	10,170	3,865.00
November	10,399	4,735.00	11,110	4,222.00
December	14,404	6,597.00	12,050	4,579.00
TOTALS	91,967	42,133.00	112,490	42,747.00

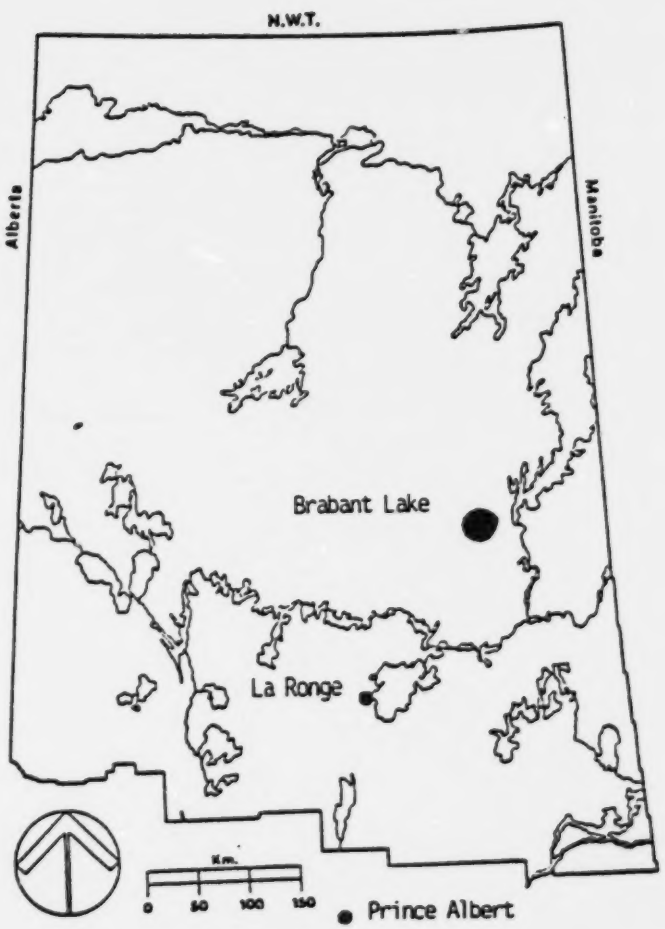
APPENDIX A

ENERGY AUDIT-BRABANT LAKE SCHOOL

ROOM BY ROOM INSPECTION

FIGURE A1

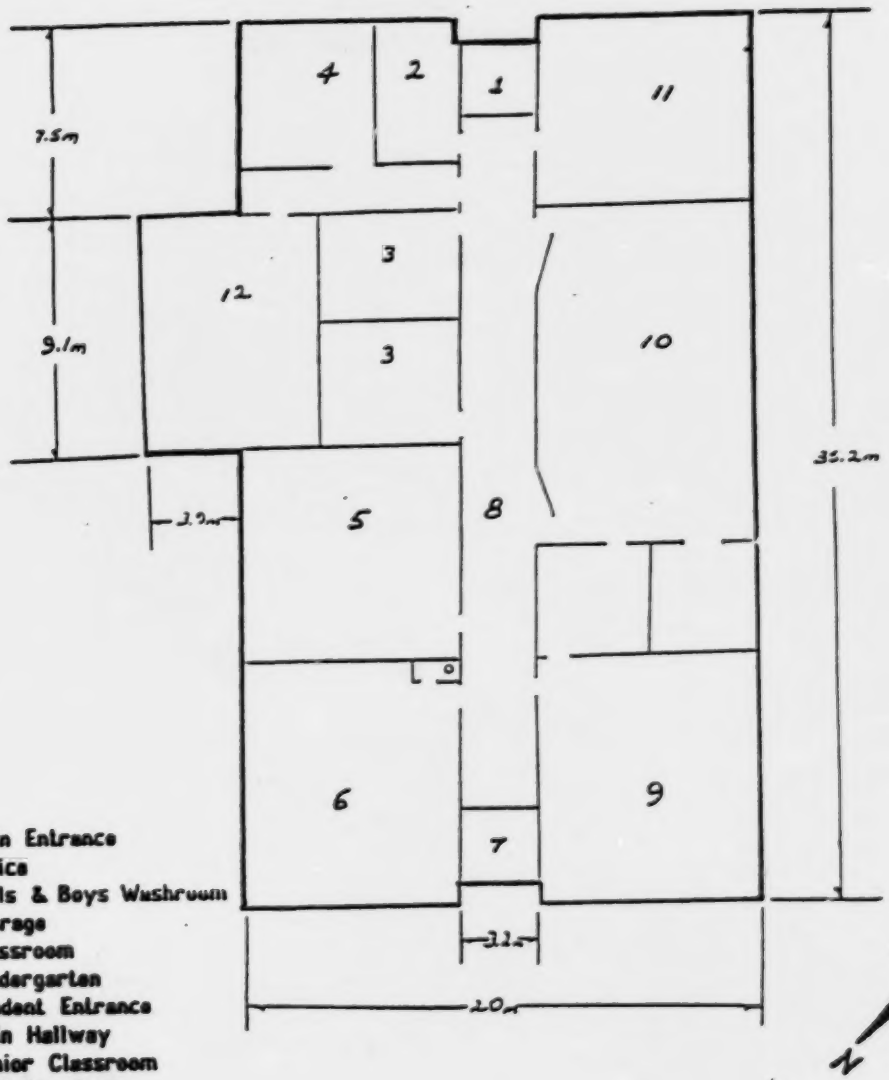
Location of Brabant Lake



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A2

Floor Plan of Office



KEY

1 Main Entrance
2 Office
3 Girls & Boys Washroom
4 Storage
5 Classroom
6 Kindergarten
7 Student Entrance
8 Main Hallway
9 Senior Classroom
10 Activity Room
11 Industrial Arts Room
12 Mechanical Room

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SHCOOL

Room by Room Inspection

1 Main Entrance

Constructed:	1978
Floor area:	8.32 m^2
Window area:	37 m^2
Door area:	3.8 m^2
Insulation levels:	Roof: RSI 5.3 Wall: RSI 3.6 Windows: RSI .32
Window type:	1/4" wire glass
Window condition:	Adequate
Caulking:	Adequate
Fit in frame:	Adequate
Window covering:	None
Door type:	Hollow metal - insulated
Door condition:	Good
Weatherstripping:	Bottom of the door needs additional weatherstripping.

Room temperature: 21°C

Humidity: Not measured

Thermostat setting: 18°C

Furnace: Two electric baseboard heaters and a hydronic heater over the door.

Lighting levels: 320 lux Recommended: 100 lux

Number of lamps burnt out: One fixture with burnt out lamps

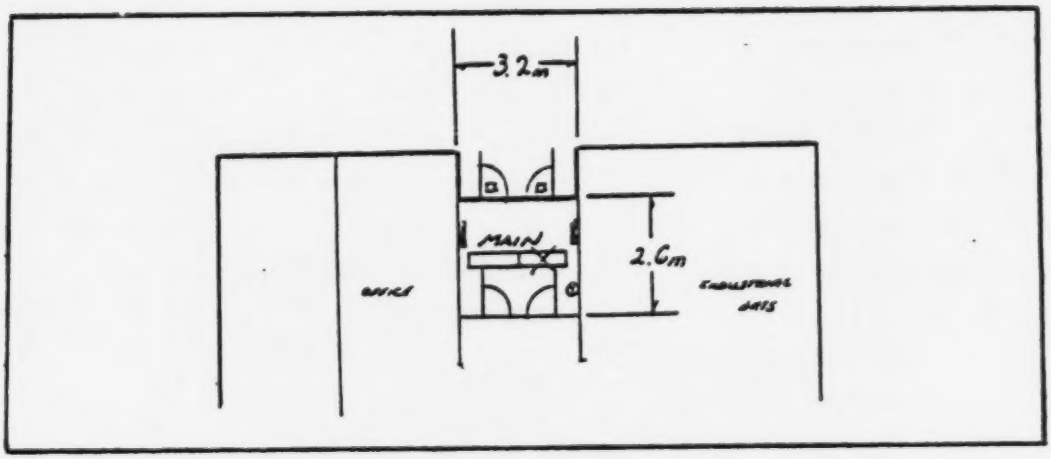
Number of lamps in poor condition: None

Comments: The inside doors are left open, therefore, the energy savings of a double door entry are negated. Also there are two electric baseboard heaters in the vestibule area.

APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

Figure A3

MAIN ENTRANCE FLOOR PLAN



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SHCOOL

2 Office

Constructed: 1978

Floor area: 17.9 m^2

Outside wall area: 9 m^2

Window area: .74 m^2

Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Windows: RSI .34

Window type: Single pane aluminum frame slider with a single pane aluminum frame storm.

Window condition: Fair

Caulking: Fair

Fit in frame: Good

Window covering: Drapes

Room temperature: 21°C

Humidity: 35% R.H.

Thermostat setting: 21°C

Furnace: Furnace #1

Lighting levels: 970 lux Recommended: 500 lux

Number of lamps burnt out: None

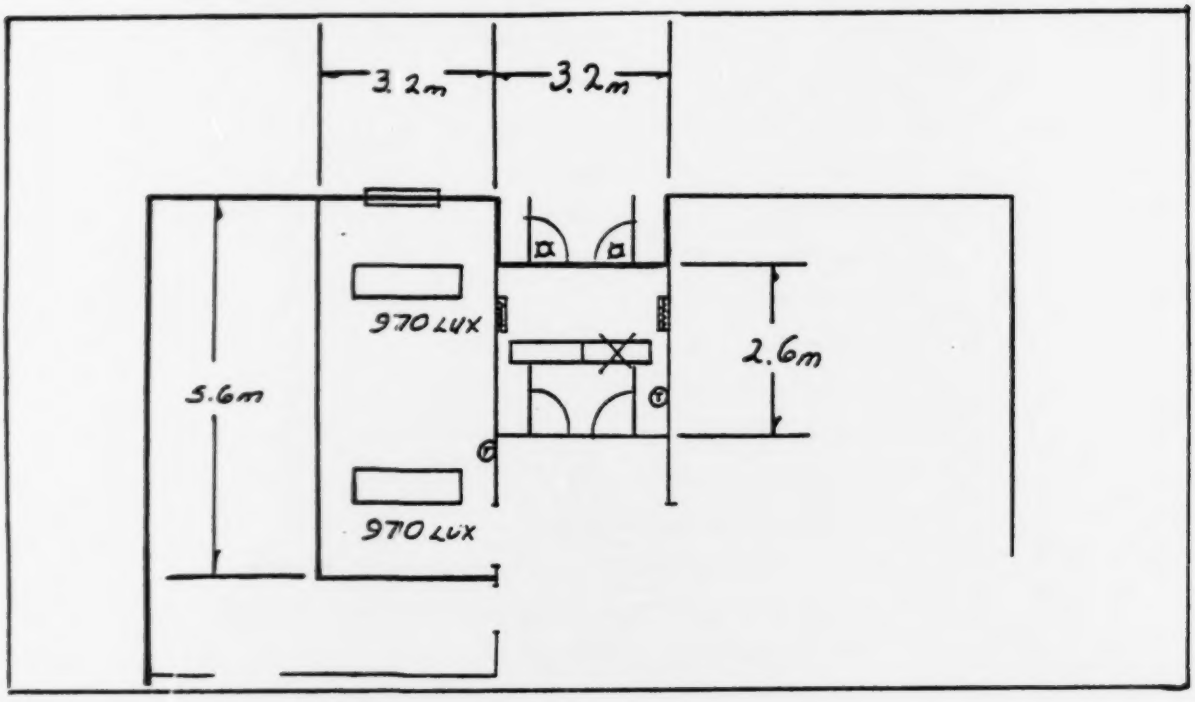
Number of lamps in poor condition: None

Comments: The office has three on/off switches to control ventilation Switch 2, 3 and 4 - the principal is not sure what they are for. The thermostat had a locked cover.

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A4

Floorplan of Office



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SHCOOL

3 Boys and Girls Washrooms

Constructed: 1978

Floor area: 49.25 m^2

Outside wall area: None

Window area: None

Insulation levels: Roof: RSI 5.3

Room temperature: 22°C

Humidity: 35% R.H.

Thermostat setting: 21°C in office

Furnace #1

Average lighting levels: 320 lux Recommended: 250 lux

Number of lamps burnt out: None

Number of lamps in poor condition: None

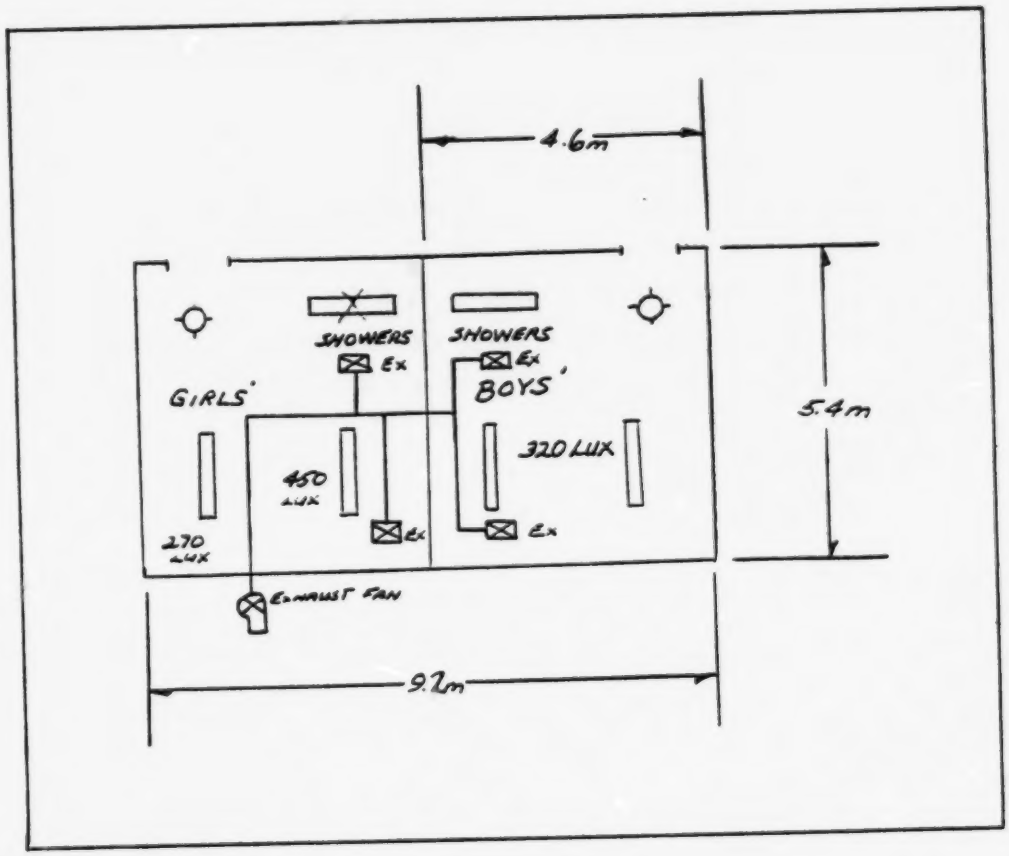
Comments: Each washroom has two exhaust fans which run continually.

The temperature of the hot water at the tap is 57°C.

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A5

Floorplan of Boys and Girls Washroom



APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

4 Storage Room

Constructed: 1978

Floor area: 133 m^2

Outside wall area: 75 m^2

Window area: 0

Insulation levels: Roof: RSI 5.3 Wall: RSI 1.8

Room temperature: 21°C

Humidity: 35% R.H.

Thermostat setting: 21°C in office

Furnace #1

Lighting levels: 250 lux Recommended: 100 lux

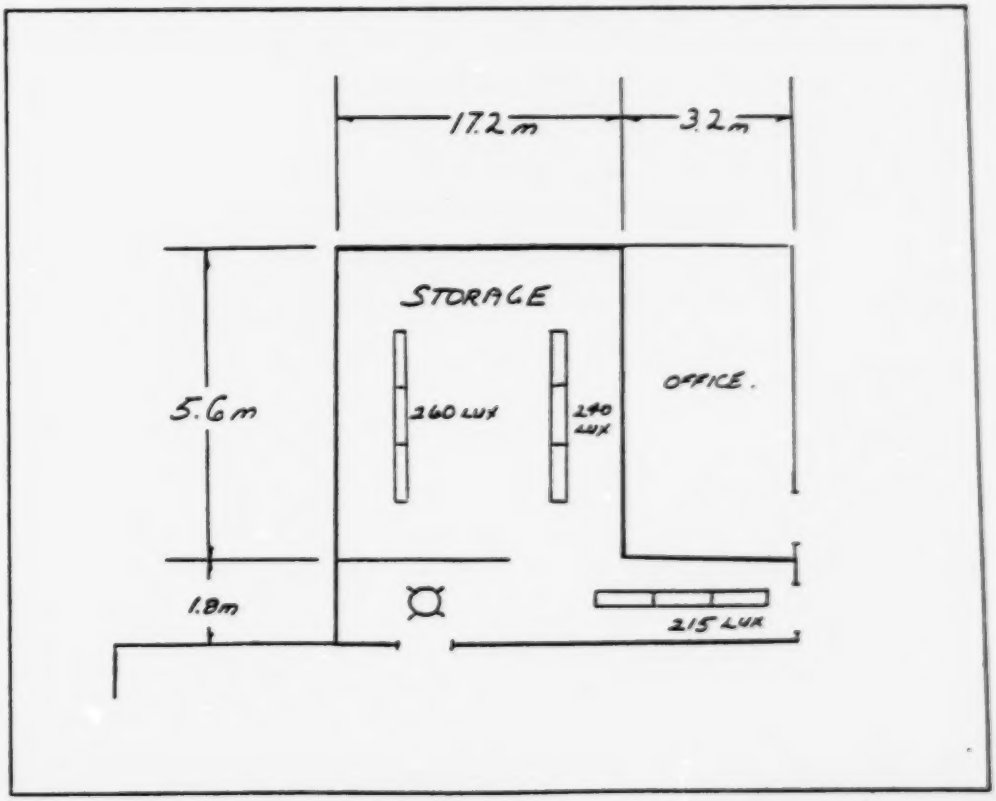
Number of lamps burnt out: None

Number of lamps in poor condition: None

Comments: This room is heated by furnace #1 and controlled by the thermostat in the office.

Figure A6

FLOOR PLANS FOR STORAGE ROOM



APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

5 Classroom

Constructed: 1978

Floor Area: 73.4 m^2

Outside wall area: 22 m^2

Window area: 4.46 m^2

Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Windows: RSI .34

Window type: Single pane aluminum frame slider with a single pane aluminum frame storm window

Window condition: Fair

Caulking: Fair

Fit in frame: Good

Window covering: Drapes

Room temperature: 20°C

Humidity: 35% R.H.

Thermostat setting: 18°C - next classroom kindergarten)

Furnace: #4

Lighting levels: 740 lux Recommended: 500 lux

Number of lamps burnt out: None

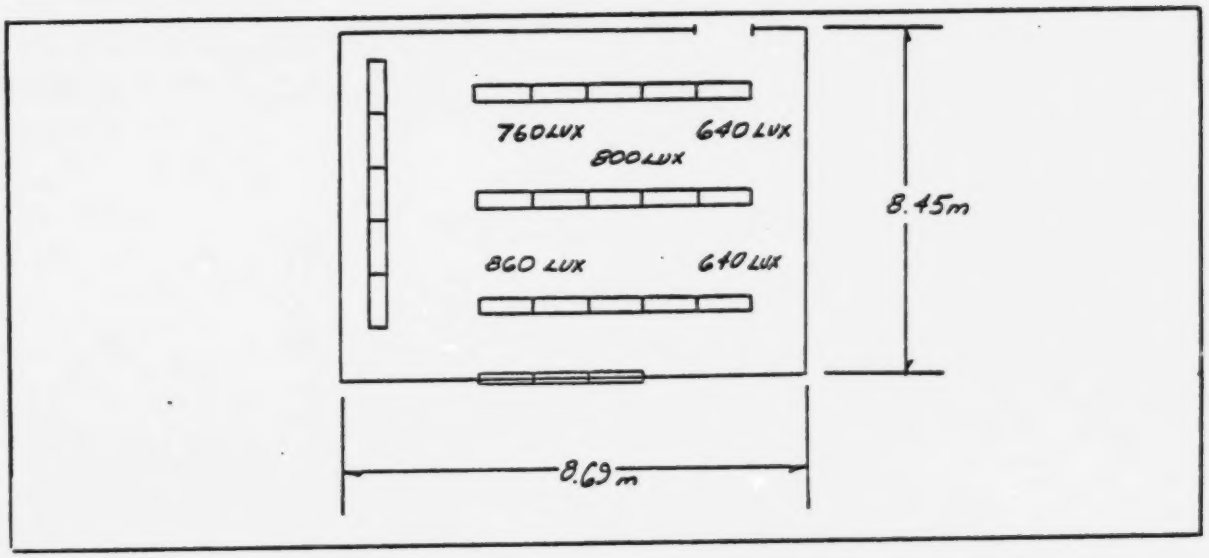
Number of lamps in poor condition: None

Comments: This room overheats. The thermostat which controls temperatures is in the next classroom (kindergarten room). Light levels exceed recommended levels. The students mentined that the lights were too bright.

APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

Figure A7

CLASSROOM



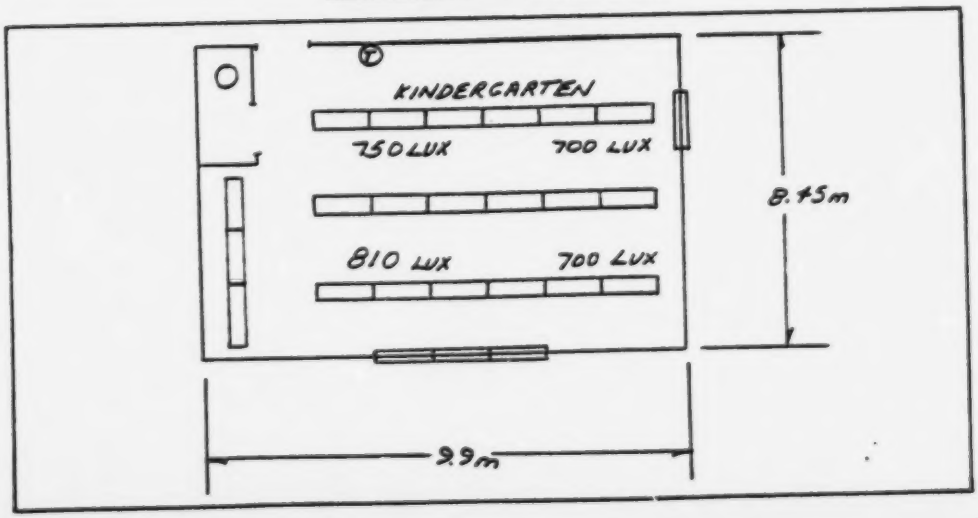
APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

6 Kindergarten to Grade 3 Classroom

Constructed: 1978
Floor area: 83.7m^2
Outside Wall Area: 50 m^2
Window area: 5.95 m^2
Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Windows: RSI .34
Window type: Single pane aluminum frame sliders with single pane aluminum frame storm windows.
Window condition: Fair
Caulking: Fair
Fit in frame: Good
Window covering: Drapes
Room temperature: 20°C
Humidity: 35% R.H.
Thermostat setting: 18°C
Furnace #4
Lighting levels: 740 lux Recommended: 500 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: The supply air ducts are clogged with dirt and garbage. The lighting levels exceed recommended level.

Figure A8

FLOOR PLAN OF KINDERGARTEN



APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

7 Student Entrance

Constructed: 1978

Floor area: 16.6 m^2

Outside wall area: 5.57 m^2

Window area: .37 m^2

Door area: 3.81 m^2

Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Windows: .32

Window type: 1/4" wire glass

Window condition: Adequate

Caulking: Adequate

Fit in frame: Adequate

Window covering: None

Door type: Hollow metal - insulated

Door condition: Good

Weatherstripping: Needs replacing

Room temperature: 21°C Humidity: 35% R.H.

Thermostat setting: 28°C

Furnace: Hydronic heater electric baseboard heaters

Lighting levels: 320 lux Recommended: 100 lux

Number of lamps burnt out: None

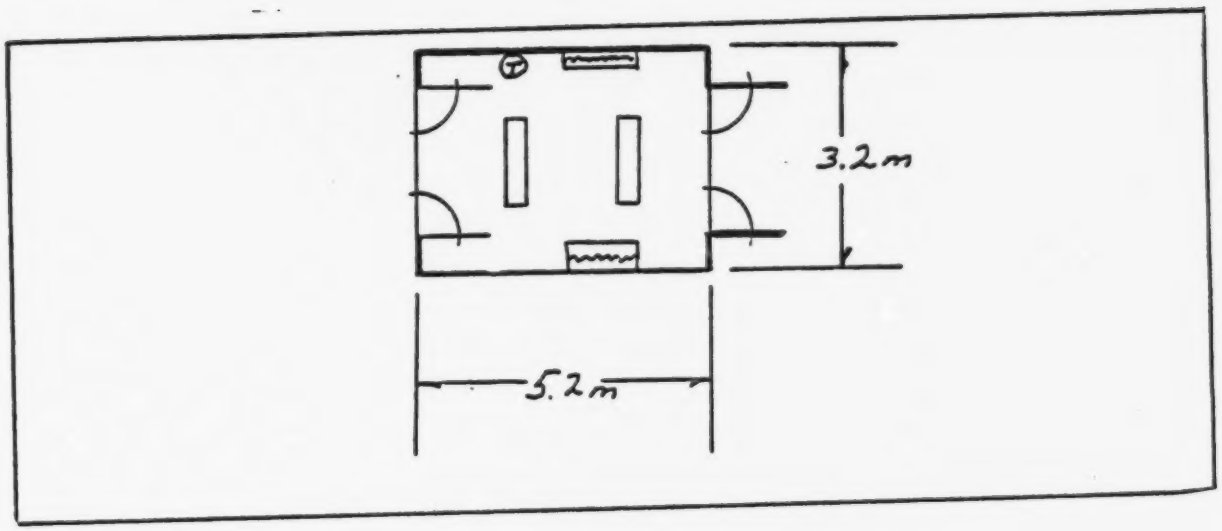
Number of lamps in poor condition: None

Comments: The inside vestibule doors are left open and therefore, the energy savings of a double door entry are negated. Also, there are two electric baseboard heaters in the vestibule area.

APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

Figure A9

FLOOR PLAN OF STUDENT ENTRANCE



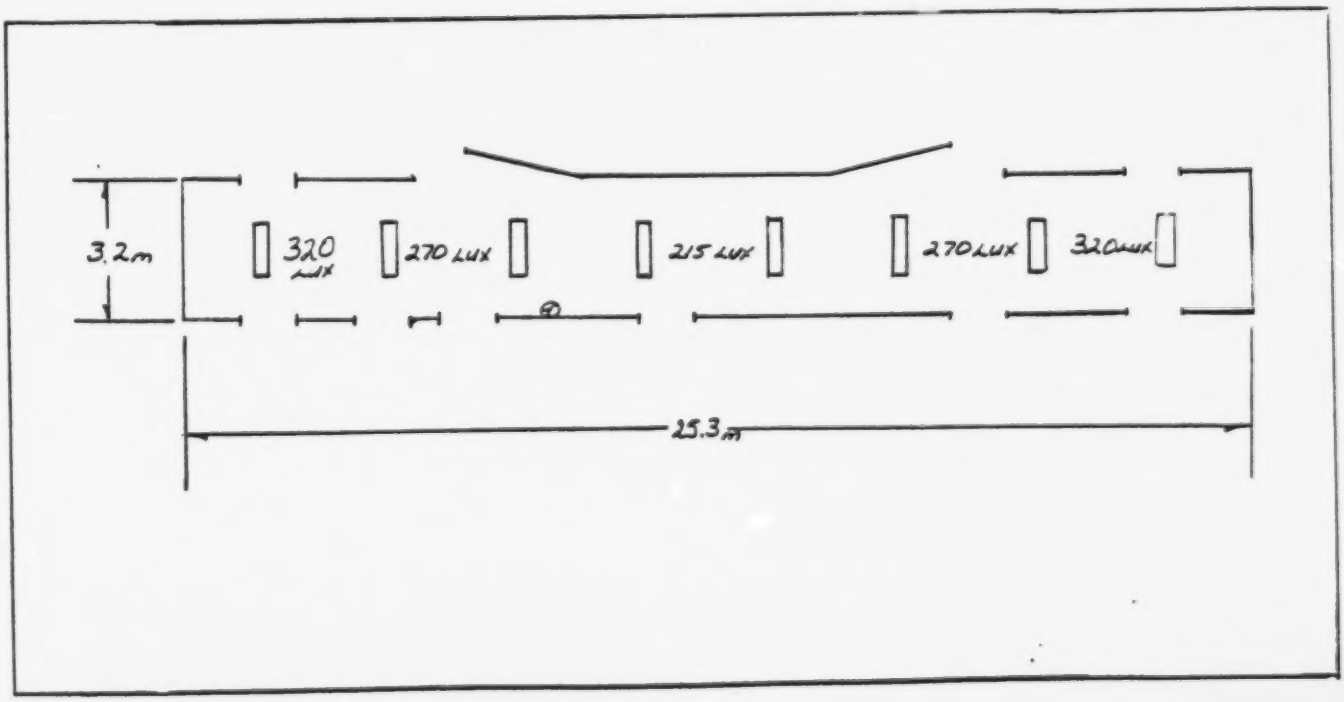
APPENDIX A - ENERGY AUDIT - BRABANT SCHOOL

8 Main Hallway

Constructed: 1978
Floor area: 81 m^2
Outside wall area: None
Window area: None
Insulation levels: Roof: RSI 5.3
Room temperature: 20°C
Humidity: 35% R.H.
Thermostat setting: 15°C
Furnace: Hydronic radiators
Average lighting levels: 250 lux Recommended: 250 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: The lighting is adequate in the hallway

Figure A10

FLOOR PLAN MAIN HALLWAY



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

9. Seniors Classroom

Constructed: 1978

Floor area: 83.7 m^2

Outside wall area: 50 m^2

Window area: 5.95 m^2

Insulation levels: Roof: RSI 5.3 Wall RSI 3.6 Windows: RSI .3

Window type: Single pane aluminum frame sliders with single pane aluminum frame storm windows.

Window condition: Fair

Caulking: Fair

Fit in frame: Good

Window covering: Drapes - At the time of audit the drapes were closed.

Room temperature: 20°C

Humidity: 35% R.H.

Thermostat setting: 20°C

Furnace #3

Average lighting levels: 800 lux Recommended: 500 lux

Number of lamps burnt out: None

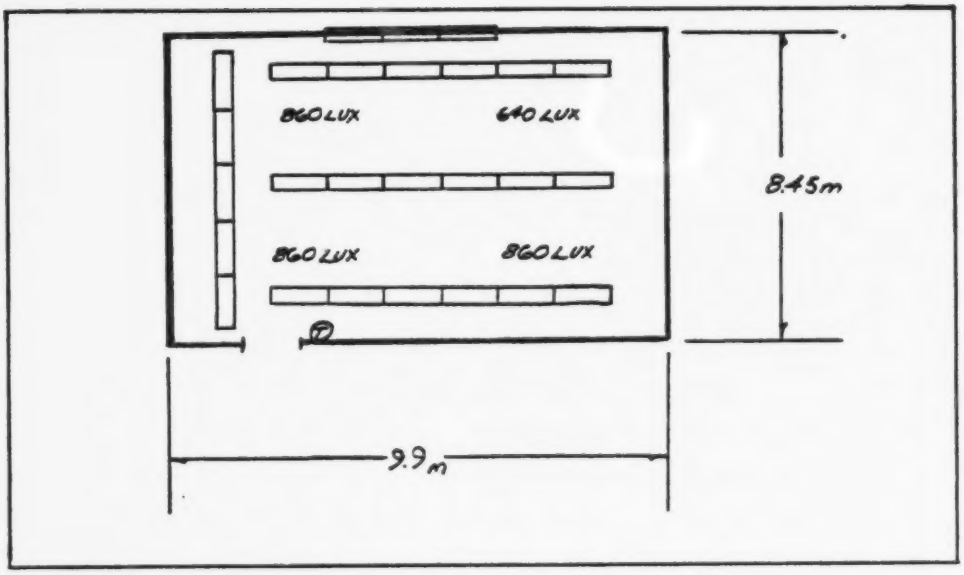
Number of lamps in poor condition: None

Comments; Ducts need cleaning

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A11

SENIORS CLASSROOM FLOOR PLAN



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

10. Activity Room

Constructed: 1978

Floor area: 110 m^2

Outside wall area: 62.4 m^2

Window area: 5.0 m^2

Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Windows: RSI 0.30

Window type: Double pane in aluminum frames

Window condition: Good

Caulking: Good

Fit in frame: Good

Window covering: None

Room temperature: 20°C

Humidity: 35% R.H.

Thermostat setting: 17°C

Furnace: #2

Lighting levels: All lights on 860 lux Recommended: 500 lux

Half the lights off in checkerboard pattern 460 lux

Number of lamps burnt out: None

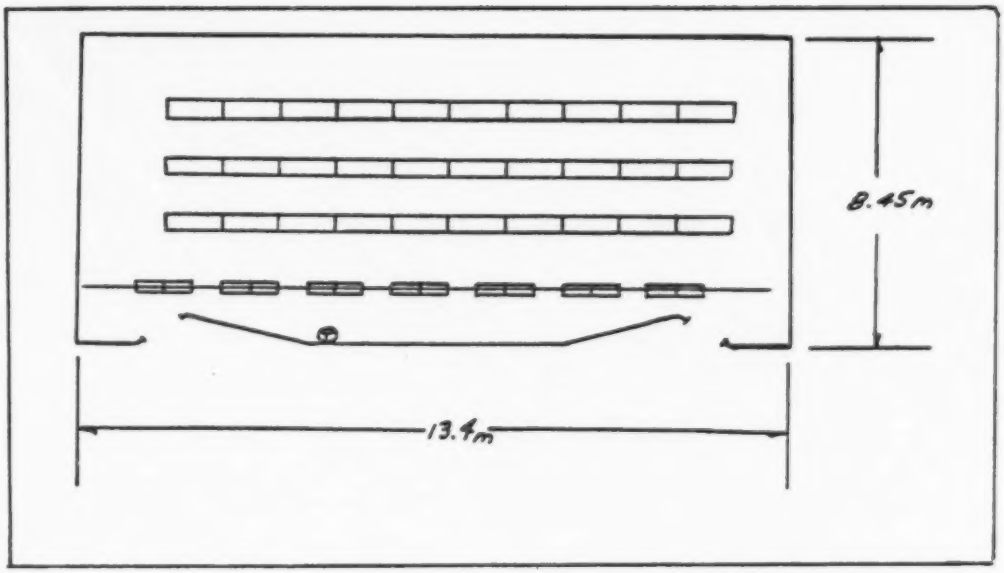
Number of lamps in poor condition: None

Comments: The ventilation system for the activity rooms outside air dampers has been disconnected from the modulating motors. The dampers are fully open. The light has two switches per panel of lights enabling the operator to turn on alternate light fixtures. Thus when half the lights are turned off and half on they make a checkerboard pattern (see Figure A 10). This lighting should be adequate for the majority of the time. The remaining lights may be turned on when "high levels of light are required. The following floor plans shows . some of the lighting patterns available.

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A12

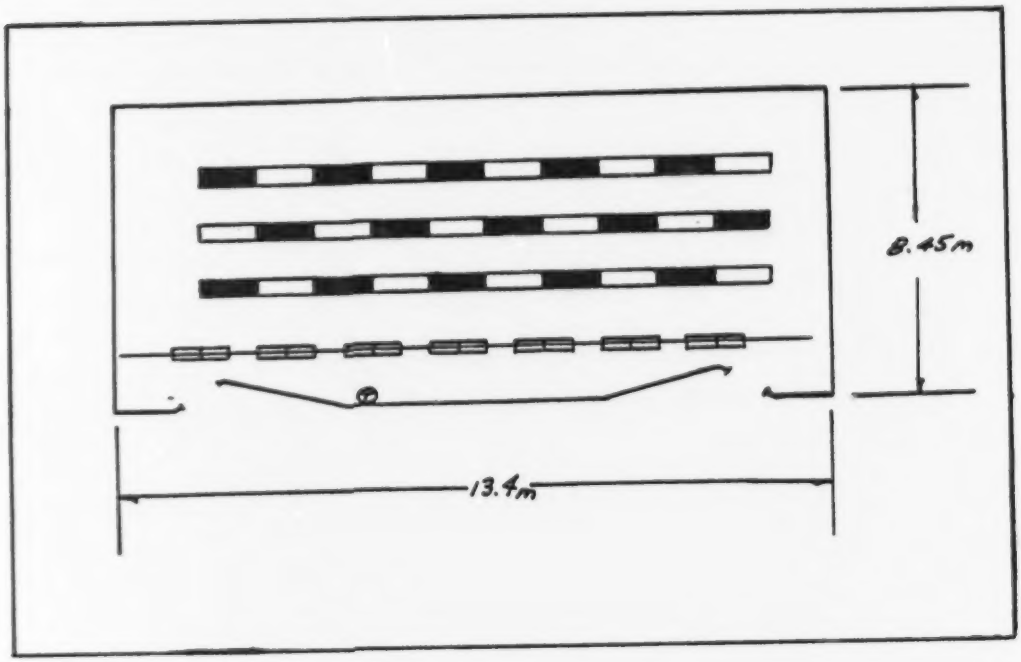
ACTIVITY ROOM FLOOR PLAN WITH ALL LIGHTS TURNED ON
THE AVERAGE LIGHTING LEVEL IS 860 LUX.



APPENDIX A - ENERGY AUDIT - BAABANT LAKE SCHOOL

Figure A13

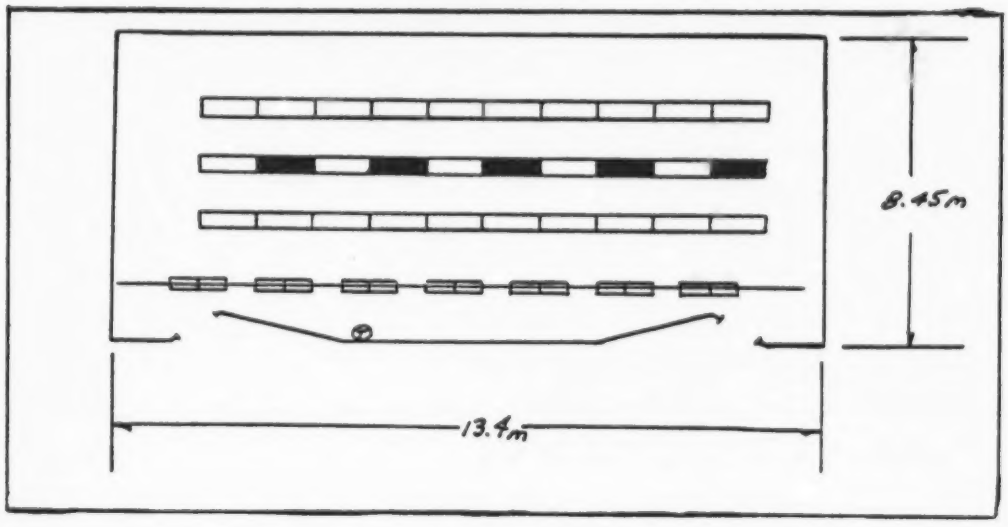
ACTIVITY ROOM FLOOR PLAN WITH HALF OF THE LIGHTS TURNED OFF
IN A CHECKERBOARD PATTERN
THE AVERAGE LIGHT LEVEL WAS 460 LUX



APPENDIX A - ENERGY AUDIT - BRADANT LAKE SCHOOL

Figure A14

ACTIVITY ROOM FLOOR PLAN WITH ONE SIXTH OF THE LIGHTS TURNED OFF.



APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

11. Industrial Arts Room

Constructed: 1978

Floor area: 63.4 m^2

Outside wall area: 62.1 m^2

Door area: 5.95 m^2

Insulation levels: Roof: RSI 5.3 Wall: RSI 3.6 Door: RSI .22

Door type: 8' x 8' overhead insulated door

Door condition: Poor fit - also has an uncovered 4 cm diameter hole for vehicle exhaust.

Weatherstripping: Inadequate

Comments: Drafty

Room temperature: 11°C

Humidity: Not measured

Thermostat setting: 12°C

Furnace: Hydronic demand heater

Average Lighting levels: 800 lux Recommended: 500 lux

Number of lamps burnt out: None

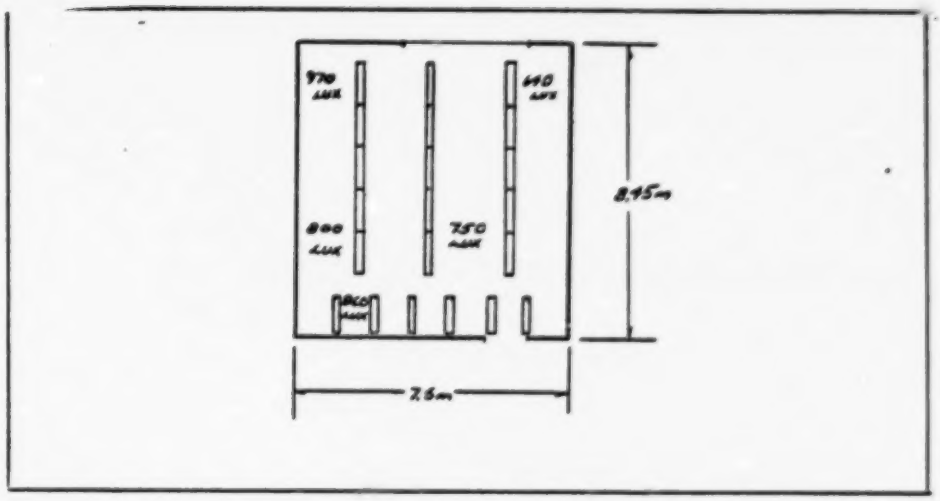
Number of lamps in poor condition: None

Comments: When the room is not being used - such as at the time of the audit, the temperature is turned down and lights are kept off and the door is kept shut.

APPENDIX A - ENERGY AUDIT - BRABANT LAKE SCHOOL

Figure A15

FLOOR PLAN OF THE INDUSTRIAL ARTS ROOM



APPENDIX A - ENERGY AUDIT-BRABANT LAKE

12. Mechanical Room

Constructed: 1978
Furnaces: Oil fired & Wood combination
Number of Fired Units: 4

Figure A16

FURNACE CHARACTERISTICS BRABANT LAKE SCHOOL

Furnace	Heating Zone	Furnace Make	Model #	Output
#1	Office, Storage Washrooms	Intercity	MFA 112	112,000 BTU/HR
#2	Activity Room	Intercity	MFA 112	112,000 BTU/HR
#3	Seniors Classroom	Intercity	MFA 112	112,000 BTU/HR
#4	Kindergarten	Intercity	MFA 112	112,000 BTU/HR

Each furnace burner incorporates a flame retention design.

Furnace Inspections:

Furnace #2 Test

Draft: .06
CO2: 8.9
Temperature: 240°C (470°F)
Efficiency: 81%
Filter: Good
Belt: Adequate

Comment: On Furnace # 3 the fan belt was very loose

APPENDIX A - ENERGY AUDIT-BRABANT LAKE

Figure A17

BOILER CHARACTERISTICS BRABANT LAKE SCHOOL

Boiler: Oil - fired Number of fired units: 1

Boiler	Heating Zone	Boiler Make	Model	Output
#1	Crawl space Hallways, Entrance, Industrial Arts	BNH	OR-280	208,000 BTU/HR

Figure A18

HOT WATER HEATER CHARACTERISTICS BRABANT LAKE SCHOOL

Domestic Hot Water Heater: Oil Fired Number of fired units: 13

DHW	Make	Model	Temperature	Capacity
#1	AREO	1000-70	71°C (168°F)	315L (70 gal)

Damper Settings:

Figure A19

FURNACE OUTSIDE DAMPER SETTINGS BRABANT LAKE SCHOOL

Outside Air Damper	Position	Damper Type
For Furnace # 1	1/2 Open	Manual
For Furnace # 2	Full Open	Automatic (disconnected)
For Furnace # 3	Closed	Automatic
For Furnace # 4	Closed	Automatic

APPENDIX A - ENERGY AUDIT-BRABANT LAKE

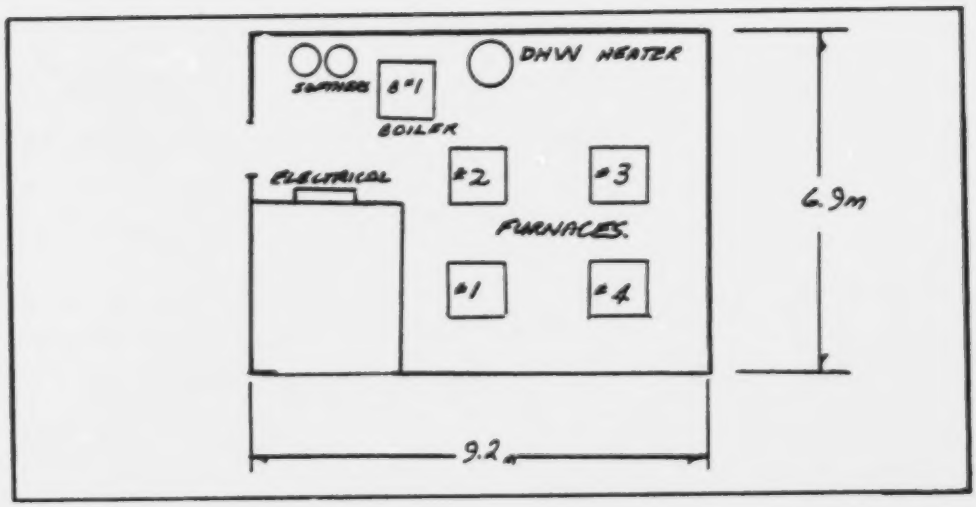
Comments:

There were also two water softners operated on by timers. The supply air ducts are in the crawl space and are supposed to be insulated with 1" of interior duct insulation.

The crawl space is heated with hydronic heaters which are thermostatically controlled. The specified temperature setting is 10°C (50°F). However, upon inspection of the crawl space, there were electric baseboard heaters in additional to the hydronic heaters. The temperature of the crawl space was 24°C (75°F).

Figure A20

MECHANICAL ROOM FLOOR PLAN



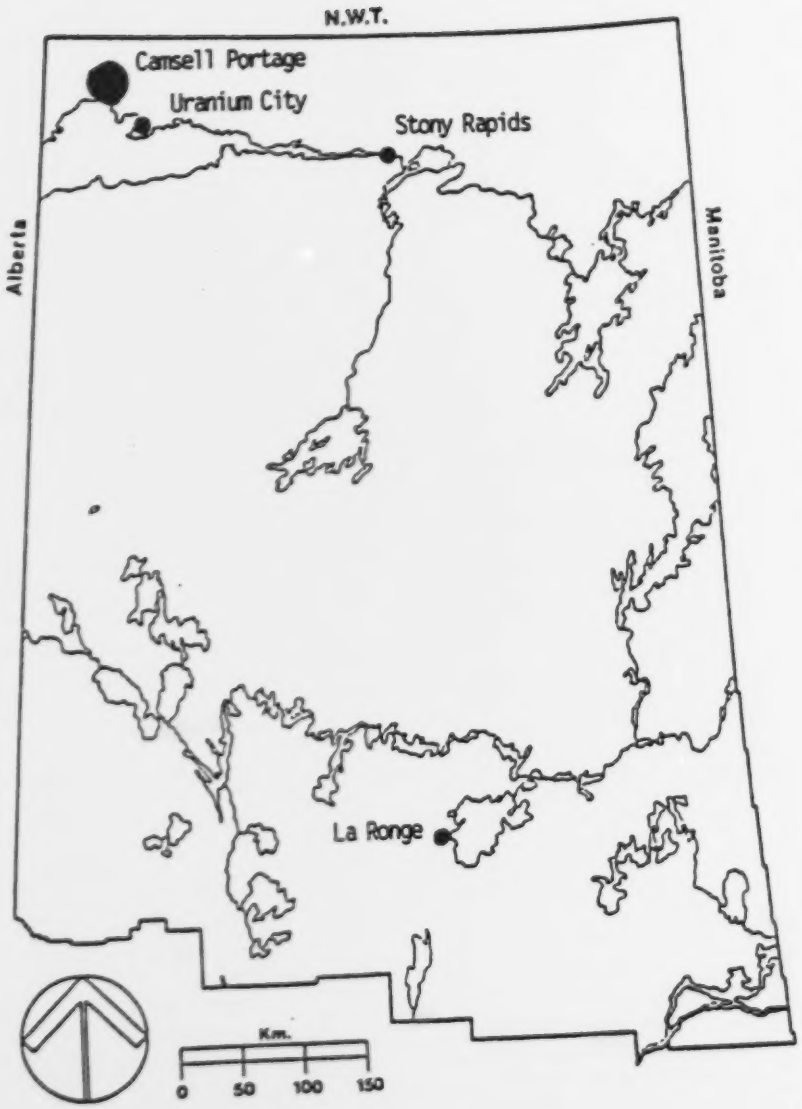
APPENDIX B

ROOM BY ROOM AUDIT INSPECTION

OF CAMSELL PORTAGE SCHOOL

Figure B1

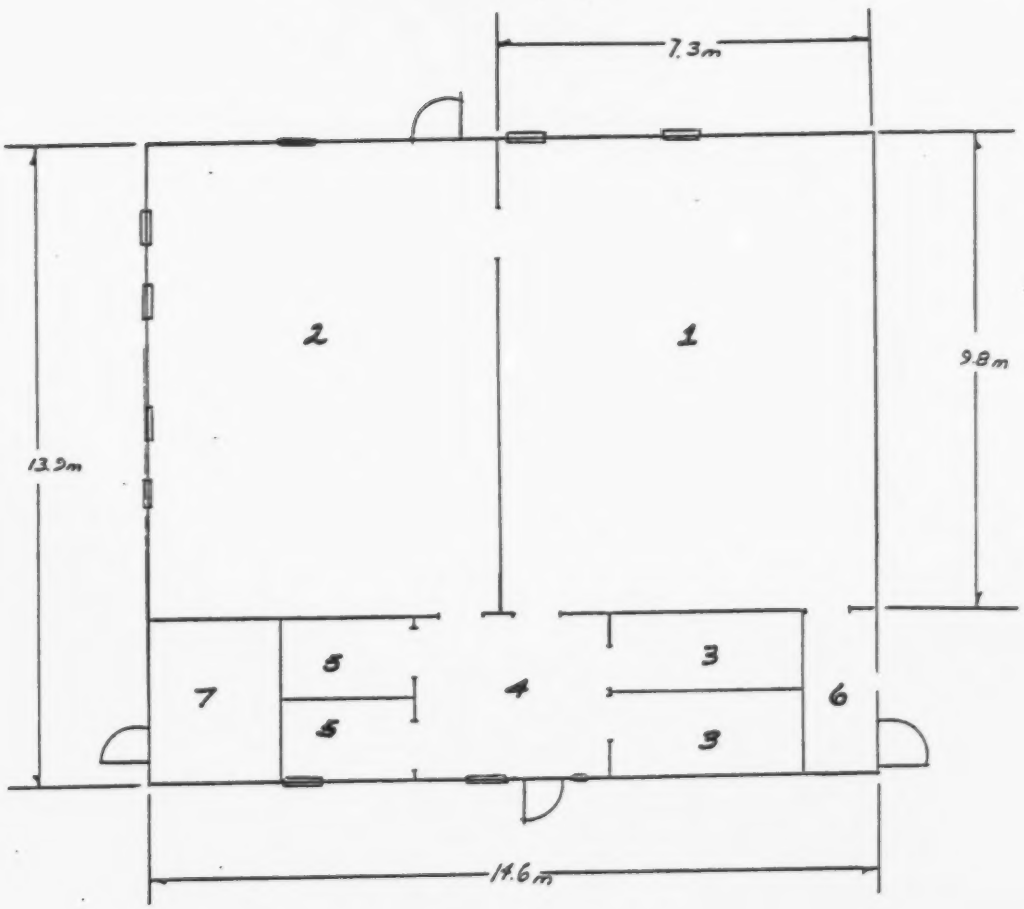
Location of Camsell Portage



APPENDIX B - ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

Figure B2

FLOOR PLAN OF CAMSELL PORTAGE SCHOOL



KEY

1. North Classroom
2. South Classroom
3. Washrooms
4. Main Entrance Vestibule
5. Shower and Storage Room
6. North Mechanical Room
7. South Mechanical Room

APPENDIX B - ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

Room by Room Inspection

1. North Classroom

Constructed:	1969
Floor area:	71 m^2
Outside wall area:	47 m^2
Window area:	4.6 m^2
Insulation levels: Roof:	RSI 2.1 Wall: RSI 1.8 Windows: RSI .16
Window type:	Single pane wood sash
Window condition:	Very drafty, one window pane is boarded over with plywood
Caulking:	Poor
Fit in frame:	Fair
Window covering:	Yes
Room Temperature:	22°C Humidity : 35% RH
Thermometer Setting:	25°C Furnace: North furnace room
Lighting levels:	300 lux Recommended: 500 lux

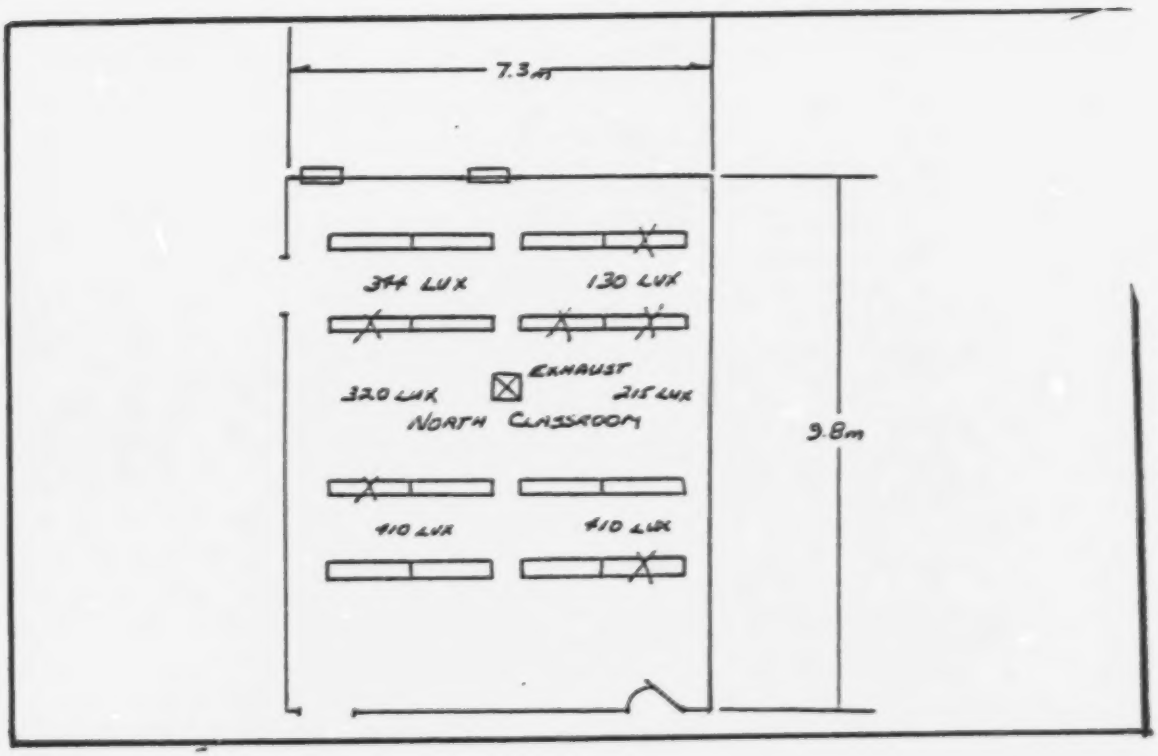
Number of lamps burnt out: 6 fixtures

Comments: In the center of the ceiling is an exhaust fan. The fan is turned on by a switch under the chalkboard. However, the fan is never used.

APPENDIX B - ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

Figure B3

FLOOR PLAN OF NORTH CLASSROOM



APPENDIX B - ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

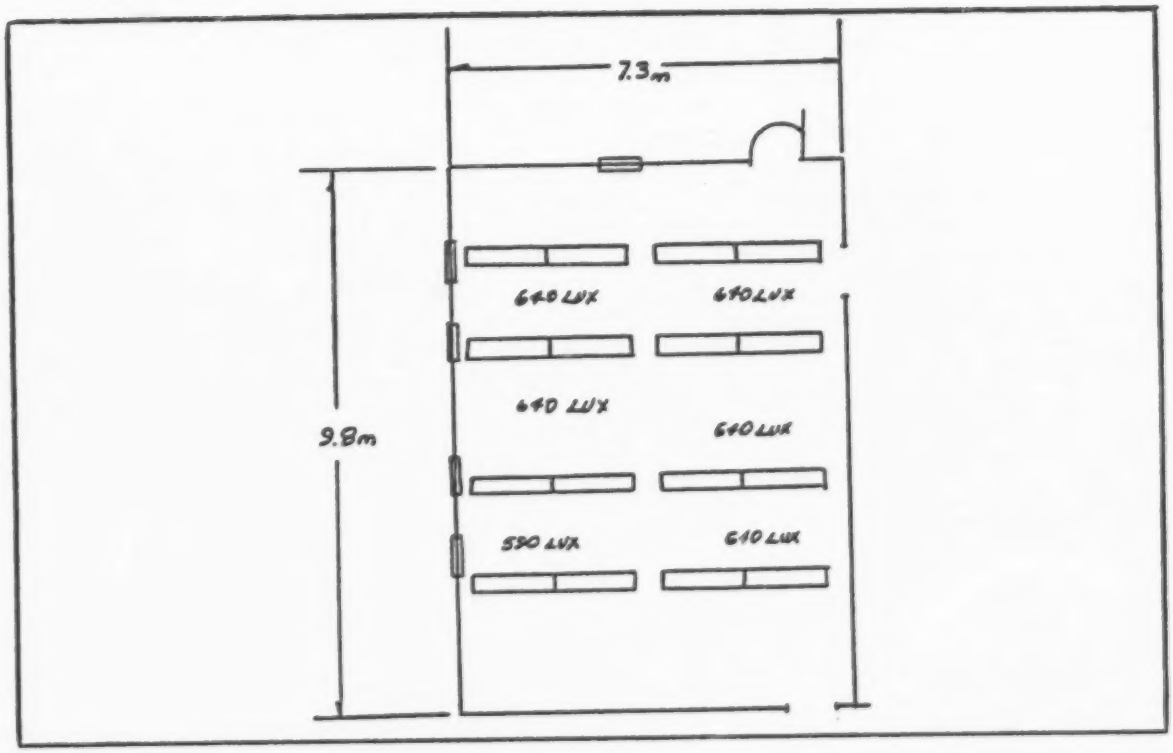
2. South Classroom

Constructed	1975
Floor area:	71 m^2
Outside wall area:	46.6 m^2
Window area:	Double glazed (D.P.) 2.2 m^2, single glazed (S.P.) 1.2 m^2
Door area:	2.0 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 1.8
	Windows: D.P. RSI .36
	S.P. RSI .16
Window type:	4 double pane in wood sash
	3.8 m x 1.5 m single pane in wood sash
Window caulking:	Double pane - good and single pane - poor
Fit in frame:	Double pane - good and single pane - fair
Window covering:	Drapes
Door type:	Solid core wooden door
Door condition:	Fair
Weatherstripping	Fair
Room temperature:	24°C Humidity: 35% RH
Thermostat setting:	22°C Furnace: South mechanical room
Lighting levels:	640 lux Recommended: 500 lux
Number of lamps burnt out:	None
Number of lamps in poor condition:	None

APPENDIX B - ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

Figure B4

FLOOR PLAN OF SOUTH CLASSROOM



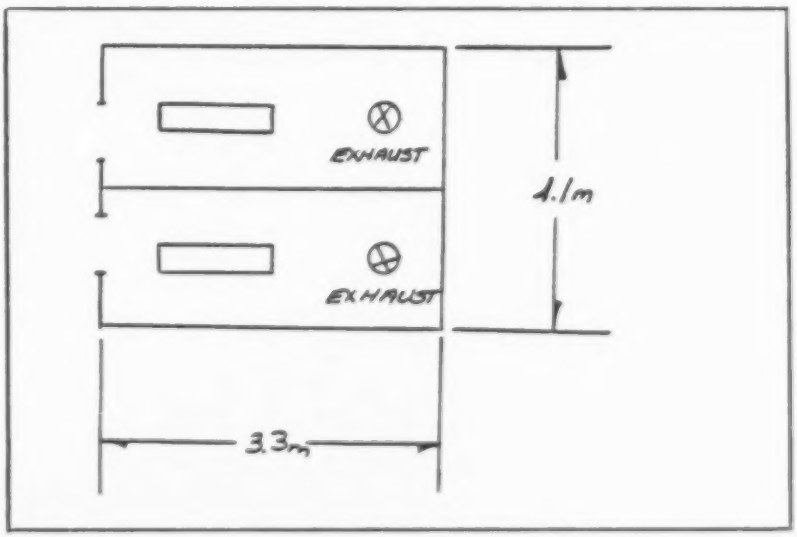
APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

3. Washrooms

Constructed: 1969
Floor area: 13.5 m^2
Outside wall area: 10.1 m^2
Insulation levels: Roof: RSI: 2.1 Wall: RSI 1.8
Room temperature 22°C Humidity: 35% RH
Thermostat setting: 25°C
Furnace: North mechanical room
Lighting levels: No measured Recommended: 250 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: The lights are turned off when not in use. The exhaust fans were not working at the time of the audit. The temperature of the hot water at the tap is 46 °C.

Figure B5

FLOOR PLAN OF WASHROOMS



APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

4. Main Entrance Vestibule

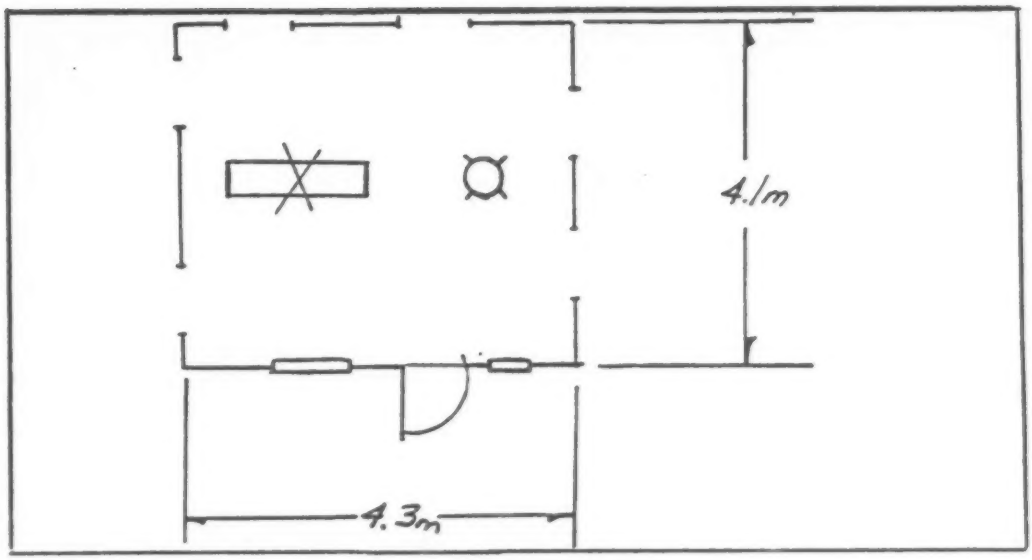
Constructed:	1969 & 1975
Floor area:	17.6 m^2
Outside wall area:	9.3 m^2
Window area:	1.6 m^2
Door area:	9.3 m^2
Insulation levels: Roof:	RSI 3.6 Wall: RSI 1.8 Windows: RSI 1.6
Window type:	Single pane in wood frames
Window condition:	Fair
Caulking:	Poor
Fit in frame:	Poor
Window covering:	None
Door type:	Solid core wood
Door condition:	Fair
Weatherstripping:	Poor - needs new weatherstripping
Room temperature:	23°C Humidity: 35% RH
Lighting levels:	Not measured Recommended: 100 lux
Number of lamps burnt out:	One
Number of lamps in poor condition:	None

Comments: The fluorescent fixture had both lamps burnt out only the incandescent fixture was working

APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

Figure B6

MAIN ENTRANCE VESTIBULE FLOOR PLAN



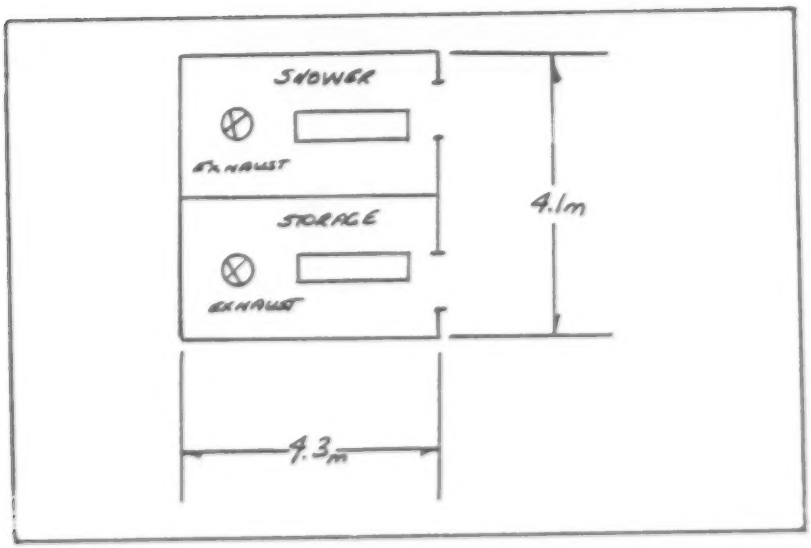
APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

5. Shower and Storage Room

Constructed: 1975
Floor area: 17.6 m^2
Outside wall area: 11.9 m^2
Window area: 1.2 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 1.8 Windows: RSI .16
Window type: Single pane in wood frame
Window condition: Fair
Caulking: Poor
Fit in frame: Fair
Window covering: None
Room temperature: 22°C Furnace: South mechanical room
Lighting levels: Not measured Recommended: 250 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None

Figure B7

FLOOR PLAN OF SHOWER AND STORAGE ROOM



APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

6 North Furnace Room

Constructed: 1969
Furnace: Oil burner Number of times fired: 1

Furance	Make	Model	Output
#1	Lennox	OF-71-189T	150,000 BTU's

Comments:

This furnace has been designated for replacement.

APPENDIX B- ENERGY AUDIT - CAMSELL PORTAGE SCHOOL

7 South Mechanical Room

Furnace: Oil burner Number of fired units: 1

Furnace	Make	Model	Output
#1	Enterprise	HBO-940	9,7000 BTU/hr

Furnace Inspection: Tests

Draft: .06
CO_2: 7.9
Temperature: 743
Efficiency: 65%
Filter - Plugged with dust
Fan belt - adequate

Note: There did not seem to be a stack controller on the furnace.

Domestic Hot Water Heater: Oil fired
Number of fired units: 1

DHW	Make	Capacity
# 1	John Wood	190 L (42 gals)

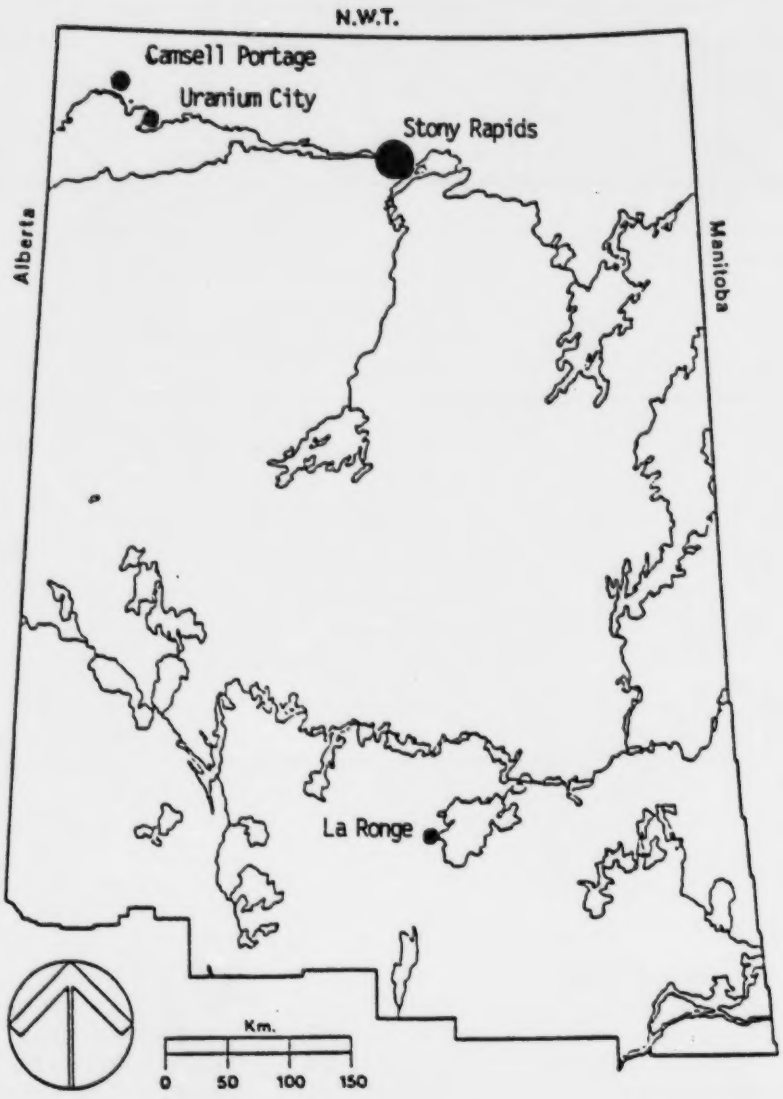
APPENDIX C

ENERGY AUDIT - STONY RAPIDS SCHOOL

ROOM BY ROOM INSPECTION

Figure C.1

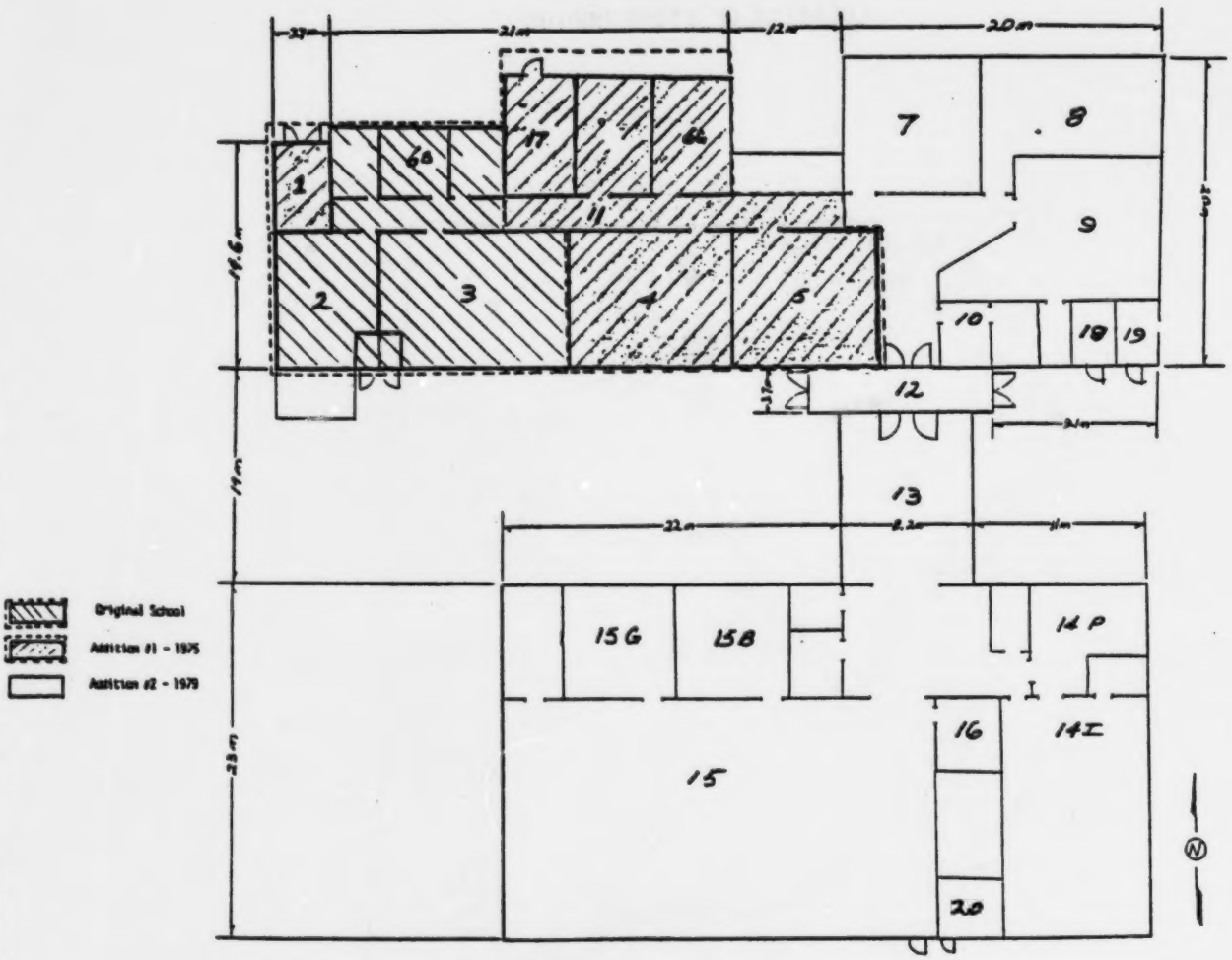
LOCATION OF STONY RAPIDS



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

FIGURE C2

FLOOR PLAN OF STONY RAPIDS SCHOOL



KEY

1. Northwest Entrance
2. Science Lab
3. Classroom
4. Home Economics Room
5. Kindergarten
6. Boys and Girls Washroom
7. Classroom
8. Classroom
9. Resource Centre
10. General and Principals Office
11. Classroom Hall Way
12. Main Entrance Vestibule
13. Link & Gym Vestibule
14. Industrial Arts & Plastics Lab
15. Gym, Girls & Boys change rooms
16. Stage Storage
17. North Mechanical Room
18. Mechanical Room
19. Generation Room
20. Mechanical Room

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

Room by Room Inspection

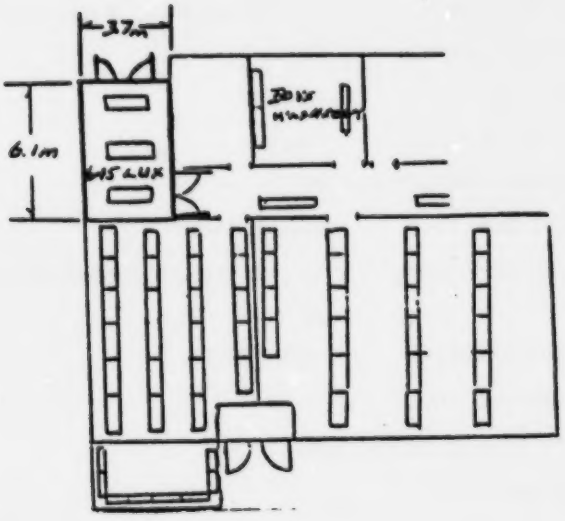
1 Northwest Entrance

Constructed: 1975
Floor area: 22.6 m^2
Outside wall area: 16.4 m^2
Window area: 1.1 m^2
Door area: 3.4 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 1.8 Windows:RSI .40
Window type: (in door assembly) double pane
Window condition: Fair
Caulking: Adequate
Fit in frame: Adequate
Window covering: No
Door type: Solid core wood
Weatherstripping: Adequate except at the bottom - 1/4" air space.
Room temperature: -2°C (29°F)
Humidity: N/A
Thermometer setting: N/A
Furnace: N/A
Lighting: 3 fixture @ 2 fluorescent 40W tubes per fixture
Average lighting levels: 645 lux Recommended: 100 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: The outside door does not close tightly unless extreme force is used and, as a result, the door is often left ajar. The vestibule doors fit well and are kept closed.

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

Figure C3

FLOOR PLAN OF MAIN ENTRANCE



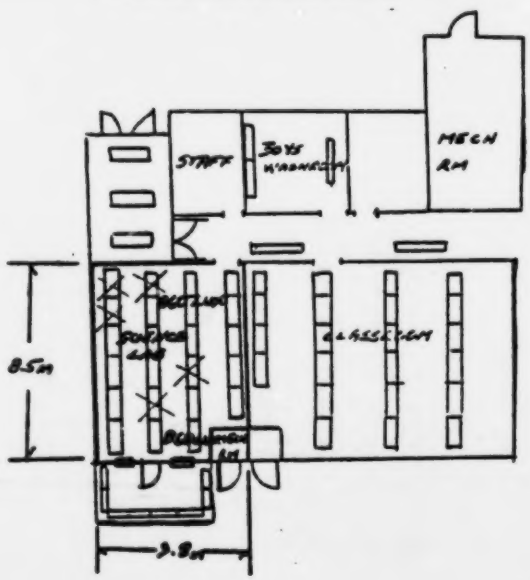
APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

2 Science Lab

Constructed: Original School
Floor area: 83.3 m^2
Outside wall area: 43.3 m^2
Window area: 1.9 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 1.8
Windows: RSI .17
Window type: 2 @ single pane in wood frames
Window condition: Poor
Caulking: Needs replacing
Fit in frame: Poor
Window caulking: None
Door type: Hollow metal - insulated
Door condition: Good
Weatherstripping: Needs stripping on bottom
Room temperature: 22°C Humidity: 31% R.H.
Thermostat setting: 23°C Furnace: in adjacent Mech. Rm.
Lighting: 23 fixtures @ 2 flourescent - 40W tubes per fixture
Average lighting levels: Class 860 lux Recommended: 500 lux
Instructor: 1130 lux Recommended: 750 lux
Number of lamps burnt out: 5
Number of lamps in poor condition: None
Comments: Doors are drafty and greenhouse has broken windows

Figure C4

SCIENCE LAB FLOOR PLAN



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

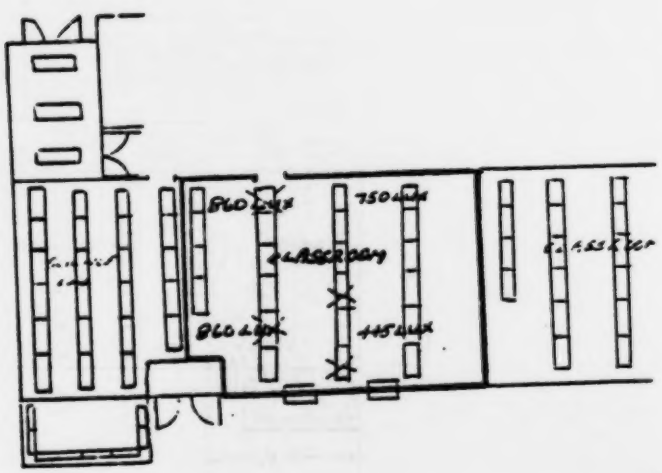
3 Classroom Next to Science Lab

Constructed:	Original building
Floor area:	83.3 m^2
Outside wall area:	18.8 m^2
Window area:	1.9 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 1.8 Window RSI .40
Window type:	2 @ single pane in wood frames
Window condition:	Poor - drafty
Caulking:	Needs replacing
Fit in frame:	Loose
Window covering:	Pin-up board sliders
Door type:	None
Door condition:	N/A
Weatherstripping:	N/A

Room Temperature: 21°C Humidity: 35% R.H.
Thermostat setting: 22°C Furnace: Adjacent mechanical room.
Lighting: 23 @ 2 flourescent 40W tubes per fixture
Average lighting levels: Class 730 lux Recommended 500 lux
Number of lamps burnt out: 4
Number of lamps in poor condition: 1
Comments: The window covers were not shut at the time of the audit. Several light fixtures are in poor condition. One reading was 445 lux - likely the lamp's rated output has worn out.

Figure C5

FLOOR PLANS FOR THE CLASSROOM NEXT TO THE SCIENCE LAB



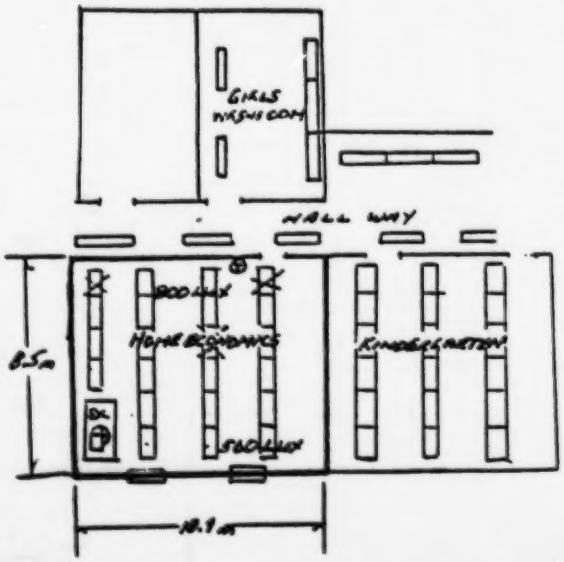
APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

4 Home Economics Room

Constructed: 1976
Floor area: 88.4 m^2
Outside wall area: 23.5 m^2
Window area: 1.9 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 1.8
Windows: RSI .17
Window type: 2 @ single pane in wood frames
Window condition: Poor - drafty
Caulking: Needs replacing
Fit in frame: Poor
Window covering: Yes
Door type: None
Door condition: N/A
Weatherstripping: N/A
Room temperature: 21°C Humidity: 35% R.N
Thermostat setting: 22°C Furnace: #3 in north mechanical room
Lighting: 22 fixtures @ 2 flourescent 40W tubes per fixture
Average lighting levels: 695 lux Recommended: 500 lux
Number of lamps burnt out: 3
Number of lamps in poor condition: (see comments)
Comments: The clothes dryer is used frequently and there was frost build-up on the range hood. The lower lighting level would indicate lamps in poor condition.

Figure C6

HOME ECONOMICS CLASSROOM FLOOR PLAN



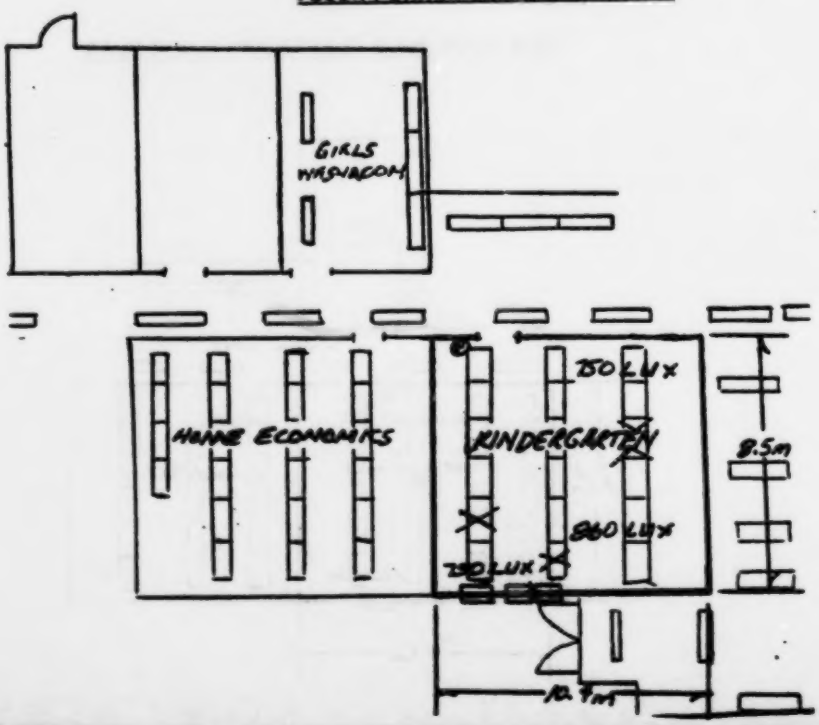
APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

5 Kindergarten Classroom

Constructed: 1976
Floor area: 88.4 m^2
Outside wall area: 19.8 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 1.8
Windows: RSI .17
Window type: Single pane in wood frames
Window condition: Poor - drafty
Caulking: Needs replacing
Fit in frame: Loose
Window covering: Yes
Door type: None
Door condition: N/A
Weatherstripping: N/A
Room temperature: 24°C Humidity: 45% R.H.
Thermostat setting: 22°C Furnace: #2 in north mechanical rm.
Lighting: 18 fixtures @ 2 flourescent 40W tubes per fixture
Average lighting levels: 780 lux Recommended: 500 lux
Number of lamps burnt out: 3
Number of lamps in poor condition: None
Comments: The drapes were closed at the time of the audit and the room seemed to be less drafty.

Figure C7

FLOOR PLANS FOR KINDERGARTEN



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

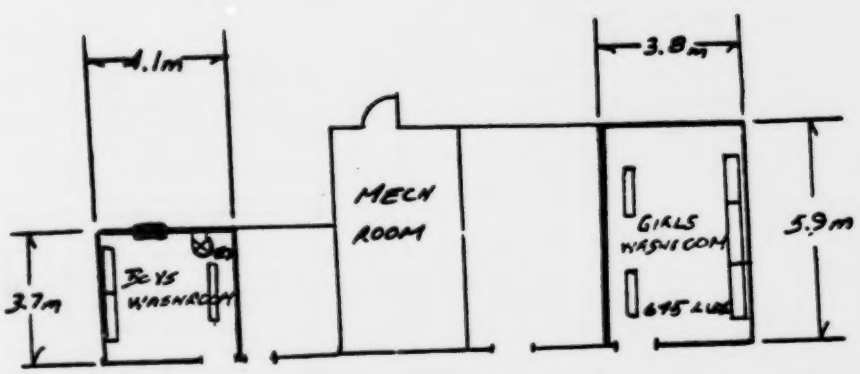
6 Boys and Girls Washrooms'

Constructed:	1976
Floor area:	Boys: 15.2 m^2 Girls: 22.4 m^2
Window area:	0.6 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 1.8 Windows: RSI .17
Window type:	Single pane wood frame
Window Condition:	Fair
Caulking:	Needs replacing
Fit in frame:	Fair
Window covering:	None
Door type:	None
Weatherstripping:	N/A

Room temperature: 21°C Humidity: 35% R.H.
Temperature at hot water tap: 66°C (154°F)
Average lighting levels: 645 lux Recommended 250 lux
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: Lights are turned on by a manual switch. Exhaust fans come on with light switch. Generally both are kept off when unoccupied. The girls washroom had a strong smell of fuel oil. The toilets run - the float sticks so that the water may run for a day or more.

Figure C8

FLOOR PLAN OF BOYS AND GIRLS WASHROOM



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

7 West Northeast Classroom

Constructed:	1979
Floor area:	$96m^2$
Outside wall area:	$36m^2$
Window area:	$3m^2$
Insulation levels:	Roof: RSI 1.8 Wall: RSI 1.8 Windows: RSI .34
Window type:	Single pane sliders in aluminum frames with a single pane in aluminum frame storm window
Caulking:	Good
Fit in frame:	Good
Window covering:	Drapes - open at the time of the audit
Door type:	None
Door condition:	N/A
Weatherstripping:	N/A

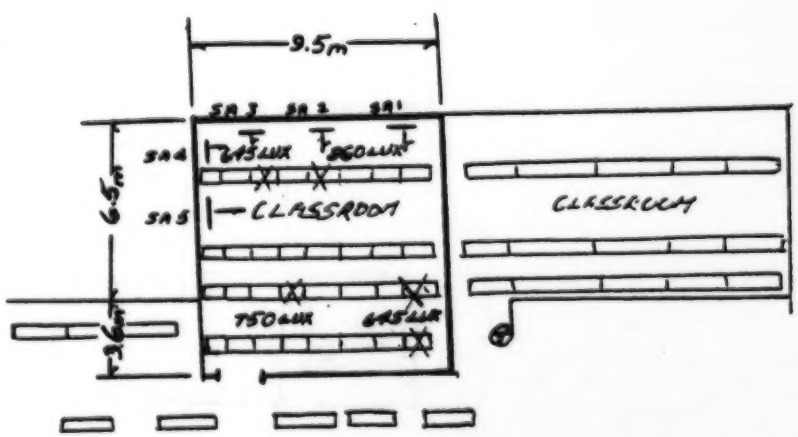
Room temperature: 21°C Humidity: 35% R.H.
Lighting: 32 fixtures @ 3 fluorescent 40W tubes per fixture
Average lighting levels: 724 lux Recommended: 500 lux
Number of lamps burnt out: 5
Number of lamps in poor condition: 5 lamps with lenses removed
Comments: This room tends to overheat - it is controlled by thermostat in the next classroom.

Figure C9

FLOOR PLANS FOR THE WEST NORTHEAST CLASSROOM

Vent Supply Air Flows

SA	Measured	Designed
1	21.2 L/s	47.2 L/s
2	24.1 L/s	47.2 L/s
3	14.6 L/s	47.2 L/s
4	7.1 L/s	70.8 L/s
5	7.1 L/s	70.8 L/s



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

8 Northeast Classroom

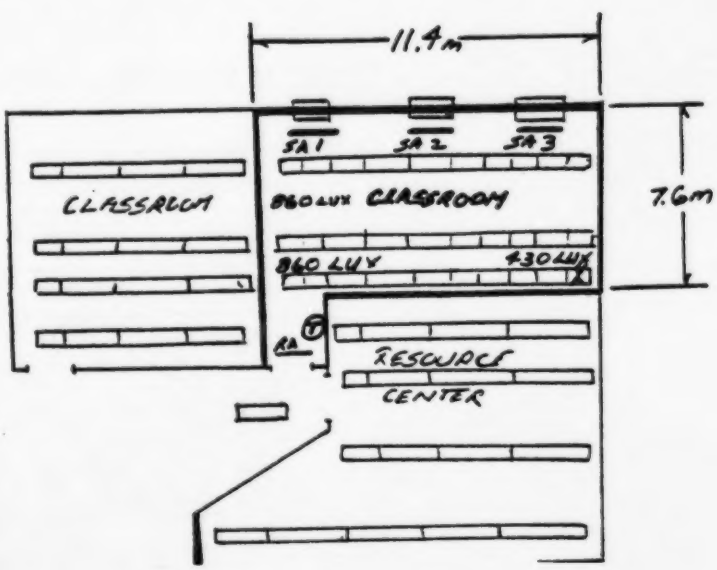
Constructed: 1979
Floor area: 86.6m^2
Outside wall area: 41.9m^2
Window area: 4.5m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 3.6
Windows: RSI .34
Window type: Single pane aluminum frame sliders with single pane aluminum storm windows
Window condition: Fair
Caulking: Good
Fit in frame: Good
Window covering: Yes - at time of audit drapes were open
Door type: None
Door condition: N/A
Weatherstripping: N/A
Room temperature: 19°C Humidity: 35% R.H.
Thermostat setting: 22°C Furnace: #5 in mechanical room next to principal's office
Lighting: 30 fixtures @ 2 fluorescent 40W tubes per fixture
Average lighting levels: 750.Lux Recommended: 500 lux
Number of lamps burnt out: 1
Number of lamps in poor condition: 3 fixtures with missing lenses.
Comments: Air flows were measured and are listed below with the design levels. This room is too cold for occupants.

Figure C10

FLOOR PLAN OF NORTHEAST CLASSROOM

Supply Air vent Flows

SA	Measured	Designed
1	21.2 L/s	94.4 L/s
2	94.4 L/s	94.4 L/s
3	45.4 L/s	94.4 L/s



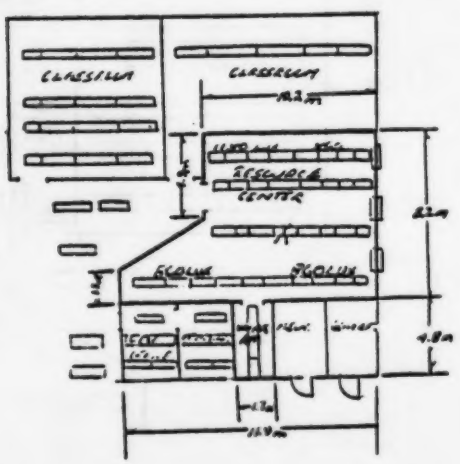
APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

9 Resource Centre And Workroom

Constructed:	1979
Floor area:	89.3 m^2 + 6.5 m^2 for the workroom
Outside wall area:	15.5 m^2
Window area:	4.5m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 3.6 Windows: RSI 3.4
Window type:	Single pane aluminum frame slider with a single pane aluminum frame storm window
Window condition:	Good
Caulking:	Good
Fit in frame:	Good
Window covering:	Yes - drapes open at the time of the audit
Door type:	None
Door condition:	N/A
Weatherstripping:	N/A
Room temperature:	25°C Humidity: 35% R.H.
Thermostat setting:	In principal's office Furnace: #4 in mechanical room next to principal's office.
Lighting:	37 fixtures @ 2 fluorescent 40W tubes per fixture
Average lighting levels:	940 lux Recommended: 500 lux
Workroom:	1,450 lux Recommended: 750 lux
Number of lamps burnt out:	1
Number of lamps in poor condition:	1 fixture with a missing lens.
Comments:	This room had a distinct smell of fuel oil - this may have been the result of the furnace having broken down earlier in the day.

Figure C11

FLOOR PLAN OF RESOURCE CENTRE AND WORKROOM



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

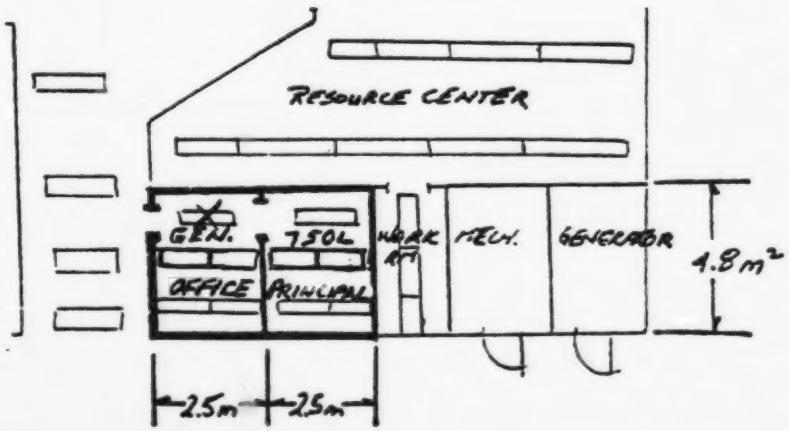
10 General Office and Principal's Office

Constructed:	1979	
Floor area:	24 m^2	
Outside wall area:	12 m^2	
Window area:	None	
Insulation levels:	Roof: RSI 3.6	Wall: RSI 3.6
	Windows: N/A	
Window type:	None	
Window condition:	N/A	
Caulking:	N/A	
Fit in frame:	N/A	
Window covering:	N/A	
Door type:	None	
Door condition:	N/A	
Weatherstripping:	N/A	
Room temperature:	22°C	Humidity: 35% R.H.
Thermostat setting:	22°C	Furnace: #4 in mechanical room next to principal's office

Lighting 10 fixtures @ 2 flourescent 40W tubes per fixture
Average lighting levels: 750 lux Recommended: 500 lux
Number of lamps burnt out: 1
Number of lamps in poor condition: None
Comments: The general office does not appear to be used very much. The controls for the fire alarm and school buzzer are located in this room. The door is kept locked.

Figure C12

FLOOR PLAN OF GENERAL AND PRINCIPAL'S OFFICE



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

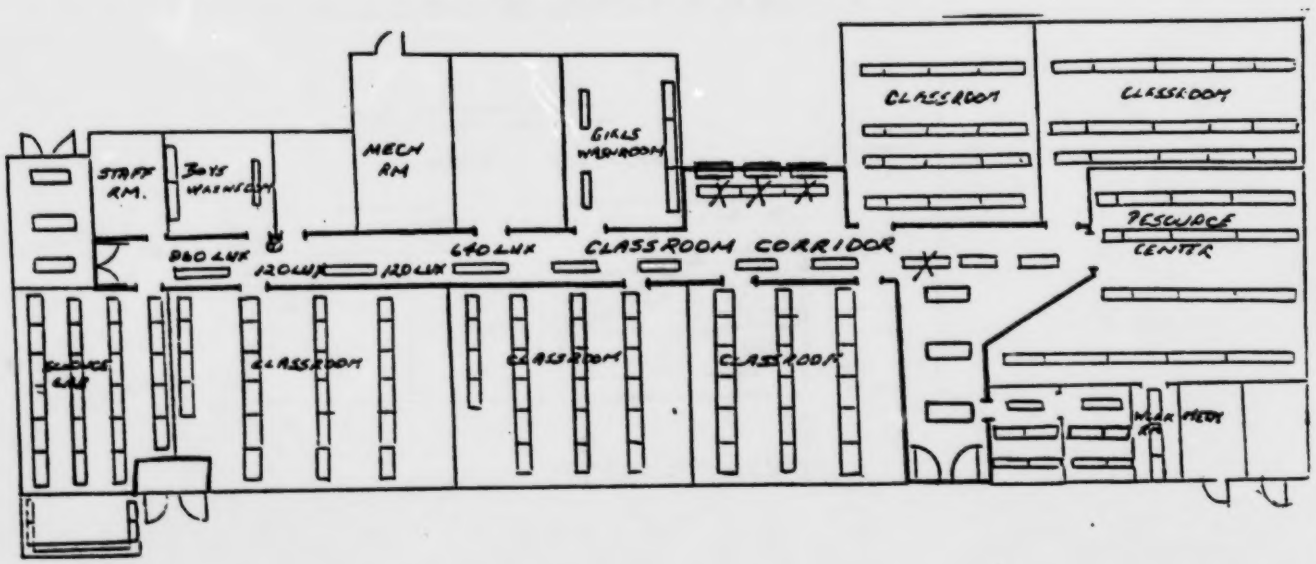
11 Classroom Corridor

Constructed:	1976
Floor area:	108.3 m^2
Window area:	7.5 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 3.6 Windows: RSI .34
Window type:	Single pane aluminum frame sliders with single pane aluminum frame storm windows
Window condition:	Fair
Caulking:	Poor
Fit in frame:	Fair
Window covering:	None
Door type:	None
Door condition:	N/A
Weatherstripping:	N/A
Room temperature:	23°C Humidity: 40% R.H.
Thermostat setting:	22°C Furnace: #4 in north mechanical room.

Lighting: 14 fixtures @ 2 flourescent 40W tubes per fixture
Average lighting levels: 400 lux Recommended: 250 lux
Number of lamps burnt out: 4
Number of lamps in poor condition: None
Comments: The light levels are not consistent down the hallway.

Figure C13

FLOOR PLAN OF CLASSROOM CORRIDOR



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

12 Main Entrance Vestibule

Constructed:	1979
Floor area:	31.6 m^2
Outside wall area:	21.3 m^2
Window area:	2.2 m^2
Door area:	6.7 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 3.6 Windows: RSI .40
Window type:	(In door assembly) Double pane
Window condition:	Fair
Caulking:	Fair
Fit in frame:	Fair
Window covering:	None
Door type:	Hollow metal insulated
Door condition:	Fair
Weatherstripping:	Poor between doors and 1/4" gap under each door
Room temperature:	11°C Humidity:
Thermostat setting:	20°C Furnace: #6 in mechanical room next to the gym
Average lighting levels:	230 lux Recommended: 100 lux
Number of lamps burnt out:	None
Number of lamps in poor condition:	None
Comments:	Outside doors do not close properly due to snow building up in door. This areas has been a problem area in that room thermostats were setback to 15°C and the pipes in the ceiling froze. A possible cause may be due to the supply air ducts being plugged with garbage, dirt and some snow. Hence, warm airflows were negligible. Also, there is a return air vent in this area drawing in air. This likely causes a negative pressure in the room which will cause cold air to infiltrate in through the space under the doors.

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

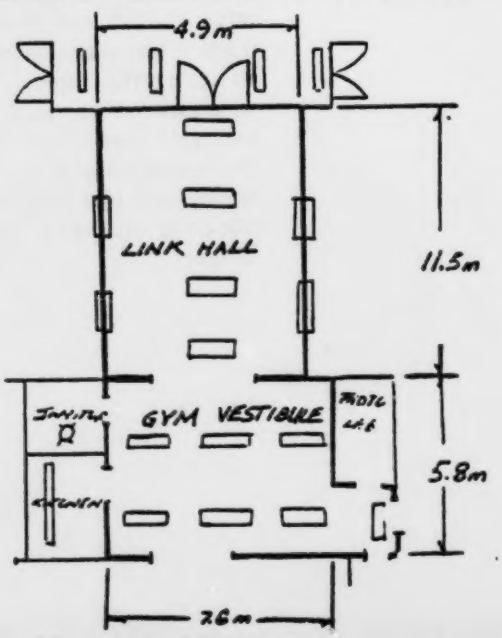
13 Link Hall and Gym Vestibule

Constructed:	1979
Floor area:	100.4 m^2
Outside wall area:	22.1 m^2
Window area:	5.9 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 3.6 Windows: RSI .34
Window type:	4 @ single pane aluminum frame slider with single pane aluminum frame storm windows
Window condition:	Fair
Caulking:	Fair
Fit in frame:	Fair
Window covering:	None
Door type:	None
Door condition:	None
Weatherstripping:	N/A

Room temperature: 13.3°C Humidity: N/A
Thermostat setting: None Furnace: N/A
Average lighting levels: 190 lux Recommended: 250 lux
Number of lamps burnt out: 2
Number of lamps in poor condition: A couple of the lamps were flickering.
Comments: One of the outside storm windows was open about one inch. Very cold hallway - drafty.

Figure C14

FLOOR PLAN OF LINK HALL AND GYM VESTIBULE



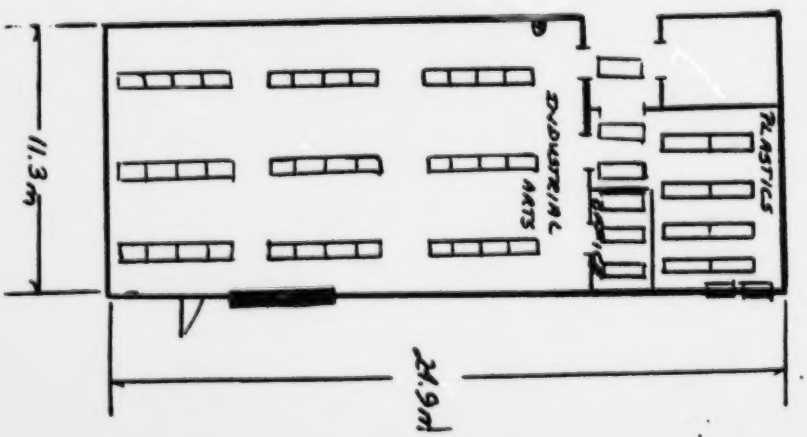
APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

14 Plastics, Electronics & Industrial Arts Lab

Constructed:	1979
Floor area:	281.4 m^2
Outside wall area:	173 m^2
Window area:	3.0 m^2
General door area:	7.43 m^2
Door area:	1.7 m^2
Insulation levels:	Roof: RSI 3.6 Wall: RSI 3.6 Windows: RSI .34
Window type:	Single pane aluminum frame slider with single pane aluminum frame storm windows
Window condition:	Fair
Caulking:	Adequate
Fit in frame:	Fair
Window covering:	Drapes
Door type:	Hollow metal insulated
Door condition:	Fair
Weatherstripping:	Adequate
Garage door:	Metal uninsulated or weatherstripped
Room temperature:	23°C Ceiling - Level 27°C Humidity: 35% R.H.
Thermostat setting:	22°C Furnace: #2 and 2A in mechanical room next to the gym
Lighting levels:	590 lux Recommended: 500 lux
Number of lamps burnt out: 4	
Number of lamps in poor condition: None	
Comments:	Large garage door uninsulated, poorly fitted and thus drafty. These rooms are supplied with 100% fresh air twenty four hours per day.

Figure C15

FLOOR PLAN OF PLASTICS, ELECTRONICS, AND INDUSTRIAL ARTS LAB



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

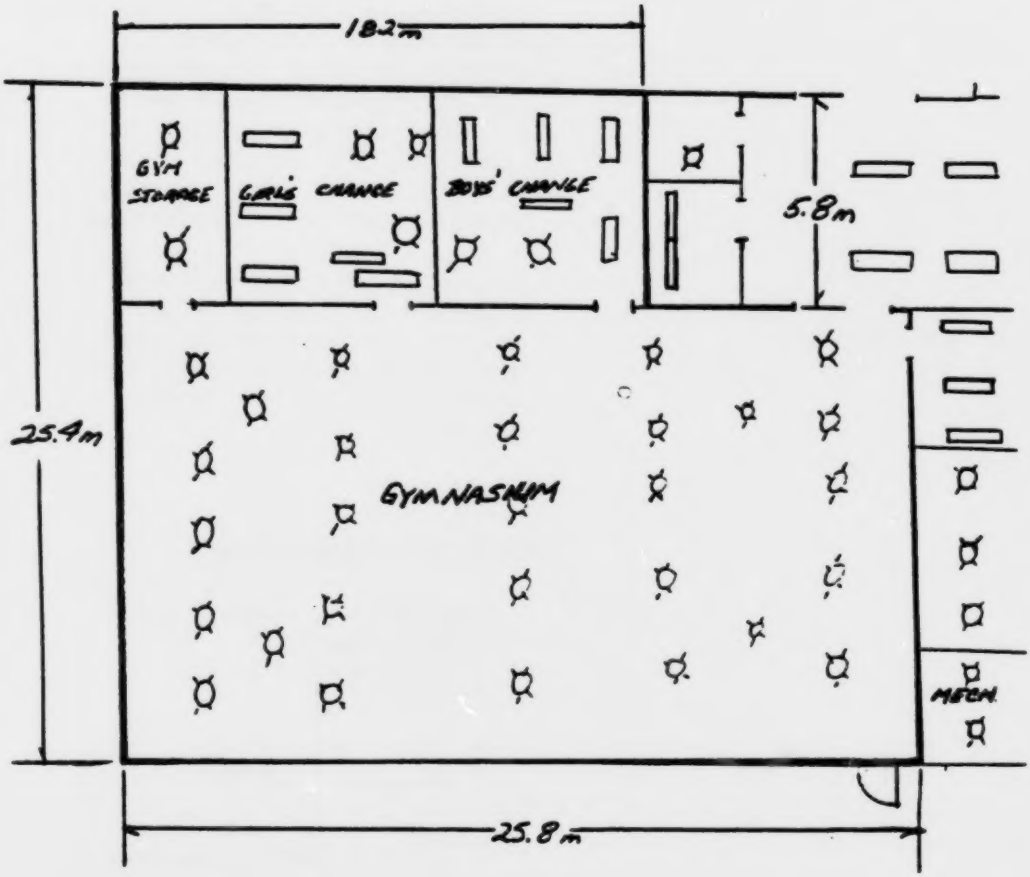
15 Gym and Gym Change Rooms

Constructed: 1979
Floor area: Gym: 506 m^2 Change area: 106 m^2
Outside wall area: 289 m^2
Window area: None
Door area: 1.7 m^2
Insulation levels: Roof: RSI 3.6 Wall: RSI 3.6
Windows: None
Door type: Hollow metal insulated
Door condition: Fair
Weatherstripping: Poor needs weatherstripping
Room temperature: 23°C Humidity: 35% R.H.
Thermostat setting: 23°C Furnace: #1, 1A, 1B, 1C
Lighting: 29 @ 400W mercury vapour lamps per fixture
10 fixtures @ 2 fluorescent 40W tubes per fixture
Average lighting level: N/A
Number of lamps burnt out: None
Number of lamps in poor condition: None
Comments: The exhaust fan works by manual switching or temperature control when on automatic.
The boys showers did not have a light.

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

Figure C16

FLOOR PLAN OF GYMNASIUM AND CHANGE ROOMS



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

16 Stage Storage

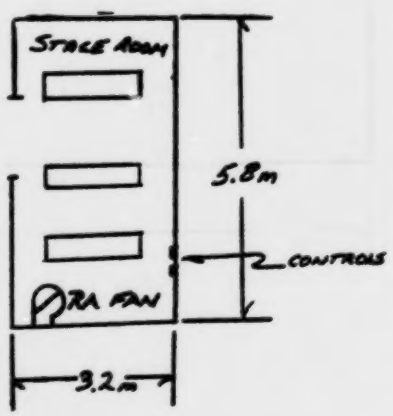
Constructed:	1979
Floor area:	18.6 m^2
Outside wall area:	None
Window area:	None
Insulation levels:	Roof: RSI 3.6
Comments:	

This room has the return air fan for the gymnasium return air system. The fan was not working at the time of the audit. The control for this fan is in the mechanical room next to the gymnasium. The control was in the off position. Also on the wall were two controls one for damper adjust ment another for day/night settings. The principel did not know what they controlled.

The day/night switch operates the outside air dampers. On day position, the gym receives fresh air and at night it is 100% return air. The damper adjustment knob sets the minimum position of the fresh air dampers.

Figure C17

FLOOR PLAN OF STAGE STORAGE



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

17 North Mechanical Room

Constructed: 1975
Furnaces: Oil Fired Number of Fired Units: 4
Furnace #1: Enterprise Model HBO 94L output 97,000 BTU/hr.

Furnace #2: Olson Model HTL 80 output 71,000 BTU/hr.

Furnace #3: Olson Model HTL 100 output 94,000 BTU/hr.

Furnace #4: Enterprise HBO 94L output 97,000 BTU/hr.

Furnace Inspections:

Furnace #1: Test #1
Draft = .04
CO_2 = 7.2
Temperature = 568 ^{0}F
Efficiency = 69%
Filter - very old and dirty
Belt is tight

Furnace #3 Test #2
Draft = .18
CO_2 = 6.3
Temperature = 615^{0}F
Efficiency = 69%
Filter - dirty
Belt is tight
Fan motor is squeaky

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

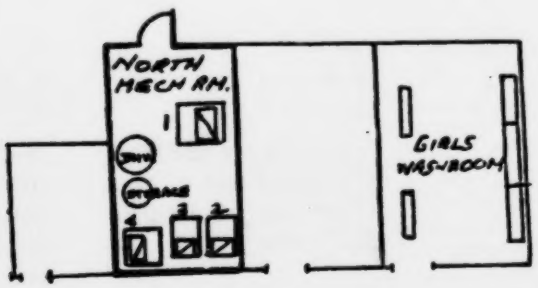
Domestic Hotwater System

Type: Oil fired Number of Heaters: One heater
One storage

Water heater: RUDD Capacity: 675L (150 gals)
Insulated: Yes
Temperature setting: Setting of water heater: 82°C (180°F)
Comments: Inspection of the oil lines in the adjacent crawled space found one line leaking oil. The filter access is not covered on Furnace #1 and air is likely drawn from the mechanical room.

Figure C18

FLOOR PLAN OF NORTH MECHANICAL ROOM



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

18 Mechanical Room Next To Principal's Office

Constructed: 1979
Furnace: Oil Fired Number of Fired Units: 3

Furnace #4: Olson Model HTL WTL 100A output 97,000 BTU
Furnace #5: Olson Model HTL WTL 100 A output 97,000 BTU
Furnace #6: Olson Model HTL WTL 100 A output 97,000 BTU

Outside air dampers are in the closed position.
Furnace Inspections:

Furnace #6:

Draft = .04
CO_2 = 6
Temperature = 490°F
Efficiency = 73%
Filter = Dirty
Fan belts = Satisfactory

Comments:

1. Room was very cold. There is a large combustion air access in the exterior wall. Half is ducted to the floor and the other half is a air duct which is blowing cold outside air onto the return air ducts. (See Figure A 35 B).

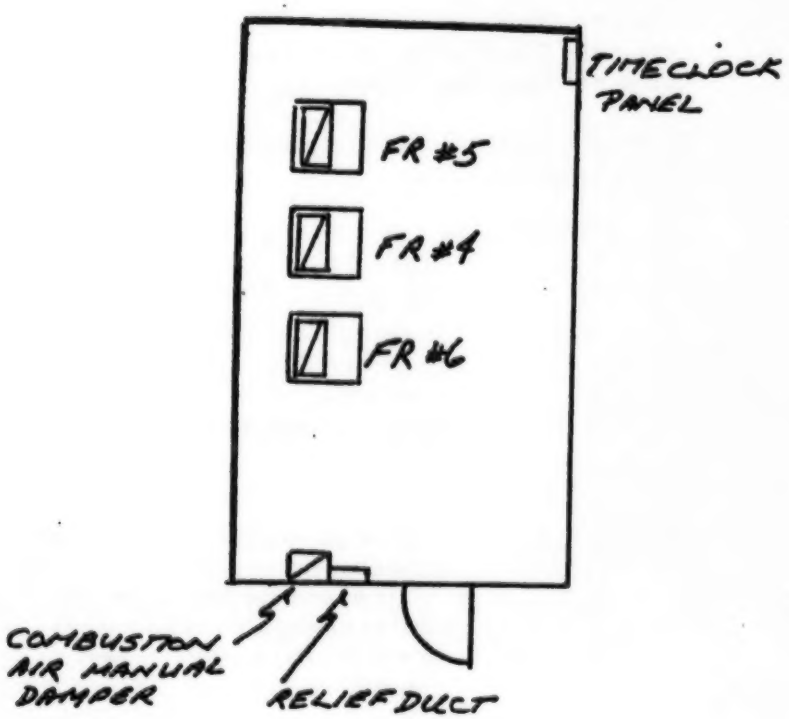
2. The is a crawlspace access in the floor. The crawlspace has the uninsulated supply air ducts running through it. The temperature of the crawlspace was 19°C and the humidity was 55% R.H.

3. There is a time clock for the outside lights. However, the time clock is installed in such a way that the access panel cannot be opened to reset the clock (See figure A 35 C)

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

Figure C19

FLOOR PLAN OF MECHANICAL ROOM NEXT TO PRINCIPALS OFFICE



APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

20 Mechanical Room Next To Gym

Constructed: 1979
Furnaces: Oil fired Number of fired units: 7

#1-A Olson HTL/WTL 100A output 97,000 BTU/hr
#1-B Olson HTL/WTL 100A output 97,000 BTU/hr
#1-C Olson HTL/WTL 100A output 97,000 BTU/hr
#1-D Olson HTL/WTL 100A output 97,000 BTU/hr
#2 Olson HTL/WTL 100A output 97,000 BTU/hr
#2A Olson WTL 100 91,000 BTU/hr
#3 Olson WTL 100 91,000 BTU/hr

Furnace Inspection
#1D

Test
Draft = .08
CO_2 = 8.9
TEMP = 493°F
Efficiency = 78%
Filters= Dirty
Belts = Satisfactory

Comments:

1. Ventilation system for the gymnasium: At the time of the audit return air fan was turned off. Outside air controller and mixed air controller were both set at 5°F. The outside air damper motor was operating even though the outside temperature was -42°C.

2. The industrial arts, plastics and electronics labs receive 100% fresh air twenty four hours a day. The fresh air damper is manually controlled.

APPENDIX C ENERGY AUDIT - STONY RAPIDS SCHOOL

Figure C20

DIAGRAM OF OUTSIDE AND RETURN AIR SYSTEM FOR GYMNASIUM

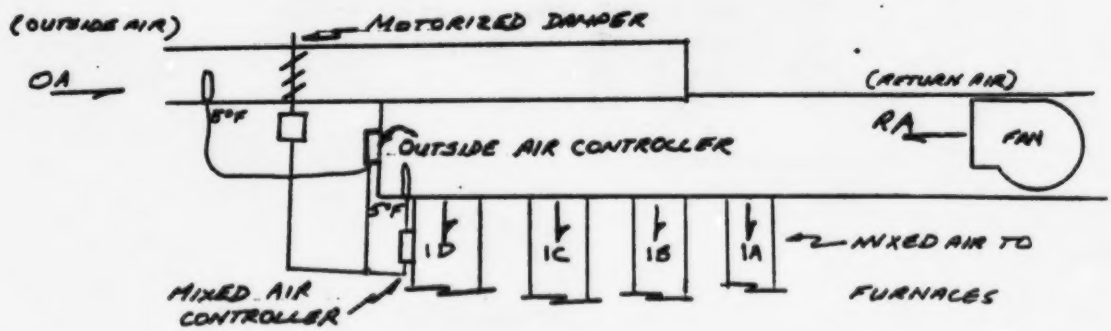
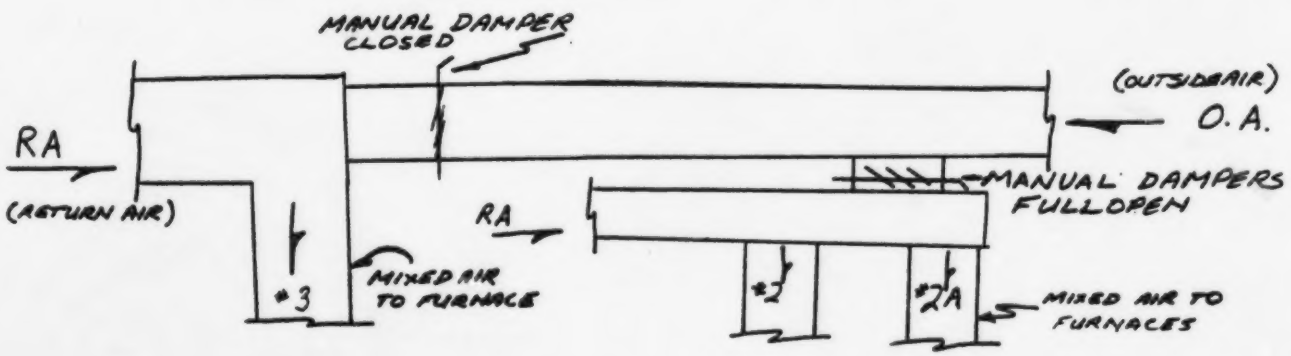


Figure C21

DIAGRAM OF RETURN AND OUTSIDE AIR SYSTEM FOR CHANGEROOM (#3) AND INDUSTRIAL ARTS AND PLASTIC AND ELECTRONICS (#2 AND #2A)



APPENDIX D

ENERGY AUDIT

BRABANT LAKE SCHOOL, CAMSELL PORTAGE SCHOOL AND STONY RAPIDS SCHOOL

MAINTENANCE INTERVIEWS

APPENDIX D - MAINTENANCE INTERVIEW

FIGURE D1

Maintenance Personnel Interview

School: Ospwakum Sepe
Location: Brabant Lake, Sask. Via: La Ronge, Saskatchewan S0J 1L0
Maintenance Person: Tom Hart, Southend, Saskatchewan

Heating units regularly cleaned — Yes ✓ No ____
How many times/year: (1) 2 3 4

Heat exchangers regularly cleaned: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Fan belts checked: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Filters checked: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Current Maintenance Practices Include:

- ✓ General Building
- ✓ Blower Cleaning
- ✓ Clean Fuel Oil Burner Pump
- ✓ Clean Fan Motor
- ✓ Change Filters

APPENDIX D - MAINTENANCE INTERVIEW

FIGURE D2

Maintenance Personnel Interview

School: Camsell Portage School
Location: Camsell Portage, Saskatchewan via Uranium City, Saskatchean S0J 2W0
Maintenance Person: Russ Ketzmerick, La Ronge

Heating units regularly cleaned — Yes ____ No ✓
How many times/year: 1 2 3 4

Heat exchangers regularly cleaned: — Yes ____ No ✓
How many times/year: 1 2 3 4

Fan belts checked: — Yes ____ No ✓
How many times/year: 1 2 3 4

Filters checked. — Yes ____ No ✓
How many times/year: 1 2 3 4

Current Maintenance Practices Include:

- General Building
- Blower Cleaning
- Clean Fuel Oil Burner Pump
- Clean Fan Motor
- Change Filters

APPENDIX D - MAINTENANCE INTERVIEW

FIGURE D3

Maintenance Personnel Interview

School: Stony Rapids School
Location: Stony Rapids, Saskatchean S0J 2R0
Maintenance Person: Russ Ketzmerick, La Ronge, Saskatchewan

Heating units regularly cleaned — Yes ✓ No ____
How many times/year: (1) 2 3 4

Heat exchangers regularly cleaned: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Fan belts checked: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Filters checked: — Yes ✓ No ____
How many times/year: (1) 2 3 4

Current Maintenance Practices Include:

- ✓ General Building
- ✓ Blower Cleaning
- ✓ Clean Fuel Oil Burner Pump
- ✓ Clean Fan Motor
- ✓ Change Filters

APPENDIX E

ENERGY AUDIT

BRABANT LAKE SCHOOL, CAMSELL PORTAGE SCHOOL AND STONY RAPIDS SCHOOL

GENERAL MAINTENANCE

APPENDIX E - GENERAL MAINTENANCE

FIGURE E1

MANUFACTURES RECOMMENDED SERVICE INFORMATION

PARTS SERVICE POINTERS

Recommended practices are:

1 - Annual inspection of the door gaskets and replacement if found leaking.
2 - Annual replacement of the burner nozzle. Use only that type and size originally supplied with furnace.
3 - Annual replacement of the air filters.
4 - Annual replacement of the oil filter.
5 - Annual servicing (replace worn parts as required).
6 - Adjustment and servicing of burner by a qualified serviceman.
7 - Oil motor bearings with a few drops of S.A.E. 20 oil every six months. (Oil burner motor and blower motor - blower bearings permanently lubricated).
8 - Replace solid fuel comubstion chamber liner(s) and grate(s) if found to be abnormally distorted.

APPENDIX E - GENERAL MAINTENANCE

FIGURE E2

ANALYSIS OF FURNACE EFFICIENCY, FROM FLUE GAS TEMPERATURE AND CO_2 READINGS

Determining furnace efficiency. Measuring and adjusting the furnace's draft and reaching a proper smoke number, set the stage for accurate CO_2 and stack temperature tests which can be used to calculate the operating efficiency of the furnace.

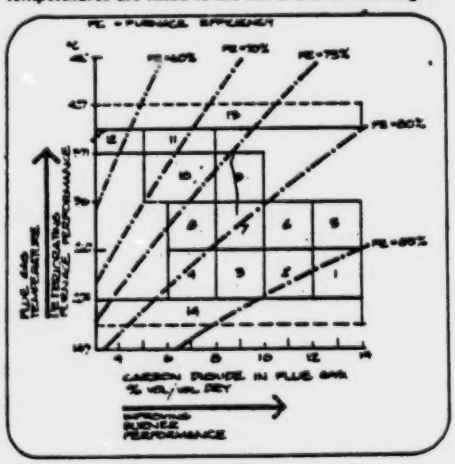
In general, a flue gas temperature above 260°C (500°F) indicates average heat exchange performance that could be improved (e.g. too much heat up the chimney). Flue temperatures of 285°C (545°F) indicate poor furnace performance. Above 315°C (600°F) the furnace is probably overfired and the nozzle size should be reduced.

Stack temperatures in the 175°C to 260°C (350°F to 500°F) range are ideal. Flue gas temperatures below 350°F can produce corrosive condensation in the chimney.

The CO_2 present in the flue gas generally ranges from 4 to 14 per cent with 9 per cent representing average performance. A concentration of 10 to 12 per cent is desirable, but often impossible to achieve in an older furnace.

By using the stack temperature and concentration figures, a steady state heating efficiency rating can be obtained.

Refer to the chart below. Carbon dioxide concentration is shown below the horizontal edge of the graph. Flue gas temperatures are listed to the left of the vertical edge of



ZONE N°	QUALITY OF PERFORMANCE: FURNACE	QUALITY OF PERFORMANCE: BURNER	EFFICIENCY RANGE (PERCENT)	COMMENTARY
1	EXCELLENT	EXCELLENT	90-83	RARELY, IF EVER ACHIEVED
2	EXCELLENT	GOOD	87-82	UNCOMMON, ONLY ACHIEVED BY BEST OF NEW EQUIPMENT (< 5 YRS OLD)
3	EXCELLENT	TYPICAL	85-80	COMMON TO NEW (< 5 YRS OLD) EQUIPMENT, RETENTION HEAD BURNERS
4	EXCELLENT	POOR	83-77	RARE
5	TYPICAL	EXCELLENT	85-82	RARE
6	TYPICAL	GOOD	84-80	UNCOMMON, EXCEPT IN GOOD RETENTION HEAD BURNERS
7	TYPICAL	TYPICAL	82-76	COMMON TO NEW (< 5 YR OLD) EQUIPMENT, RETENTION HEAD BURNERS
8	TYPICAL	POOR	80-72	[illegible] (WITH STANDARD HEAD BURNERS) THIS IS GOOD PERFORMANCE.
9	POOR	TYPICAL	80-74	COMMON IN NEW EQUIPMENT IT IS EVIDENCE OF POOR HEAT EXCHANGER DESIGN OR OVERFIRING
10	POOR	POOR	76-68	COMMON IN OLD SYSTEMS WHERE AGAIN IT IS EVIDENCE OF OVERFIRING OR INADEQUATE HEAT EXCHANGER DESIGN
11	BAD	POOR	74-61	BOTH CATEGORIES ARE UNCOMMON EXCEPT IN THE OLDEST OF SYSTEMS. THIS PERFORMANCE IS VERY POOR.
12	BAD	BAD	BELOW 61	
13	COMPLETELY UNACCEPTABLE. FLUE-GAS TEMPERATURES ABOVE 400°C CONSTITUTE A MATERIALS PROBLEM AND A FIRE HAZARD			UNSAFE OPERATION FROM THE POINT OF VIEW OF FIRE HAZARD
14	COMPLETELY UNACCEPTABLE. FLUE-GAS TEMPERATURES BELOW 200°C CAN CONSTITUTE A CORROSION HAZARD			UNSAFE OPERATION FROM THE POINT OF VIEW OF THE STRUCTURAL STABILITY OF THE CHIMNEY

SOURCE: THE BILLPAYER'S GUIDE TO HEATING SYSTEMS. ENERGY, MINES AND RESOURCES CANADA, APRIL 1983.

APPENDIX E - GENERAL MAINTENANCE

FIGURE E3

RECOMMENDED LIGHTING PROCEDURES

7. Making the Most of Your Lighting System: Basic Considerations

Before attempting to make your present lighting system more effective and energy efficient, ask yourself this question: Is the lighting system a good one and appropriate to the space? If the system is neither effective nor in good shape, consider replacing it.

The first step in making an appraisal of the present system is to measure the illuminance – the light level – in the various spaces. A light meter measuring to an accuracy of about ± 10 per cent will be adequate. (This accuracy will not be achieved with the cheapest light meters.) The illuminance in a space will vary from place to place: the degree of variation depends on the luminaire light distribution, the luminaire spacing, and the mounting height.

Compare the measured illuminances with those recommended in Table 1. There is no need for the two sets of illuminances to line up exactly since the eyes perform satisfactorily over a wide range of conditions.

Other aspects of the lighting system that should be investigated are as follows:

- the amount of glare caused by the lighting: Does the lighting suddenly become more comfortable if you shade your eyes with your hand? If so, there is too much glare.
- the colour rendering characteristics of the lamps: Are some colours accentuated or made to look dull or otherwise unacceptably distorted? Is there a need for lamps with particularly good colour rendering (e g , in an art classroom)?
- the general condition of the luminaires: Have the luminaires been poorly maintained, with cracked, discoloured or missing lenses, and reflectors with ground-in dirt?
- the location of the working positions with respect to the luminaires and windows.

If you have decided that the present lighting system is worth retaining, a number of procedures can be adopted which will enable you to save energy consumption and costs as well as increase the effectiveness of the system. Some of these procedures can be carried out without any capital investment; others will require some additional outlay, but they can be expected to pay for themselves within a fairly short time.

Whatever you do, remember that the most efficient way of saving electrical energy – and the cost of that energy – is to *switch off the lamps when they are not required.*

Incandescent lamps should be switched off as soon as they are not required: their life is not affected by the number of times they are switched. Switching does, however, affect the life of fluorescent and high intensity discharge (HID) lamps. Accordingly, a compromise must be reached between the energy saved by switching and the reduction in lamp life – with the consequent earlier lamp replacement – resulting from the switching. Remember that as a general rule, if fluorescent lamps are not to be used for five minutes or more they should be switched off; if HID lamps are not to be used for an hour or more they should be switched off.

Procedures requiring no capital investment

1. Remove unnecessary luminaires.

It is recommended that the luminaires be removed rather than just the lamps (as is frequently suggested) because a number of luminaires without lamps will look unsightly and could spoil the appearance of the space concerned. A lighting system that looks makeshift today will go on looking makeshift for the next fifteen years unless something is done about it.

However, it may not be possible to remove luminaires, but only lamps. If these are fluorescent or HID lamps, the ballasts in the luminaires should be disconnected since they will continue to consume energy even if no lamps are connected to them. For example, a commonly-used ballast for two 40 W Rapid Start fluorescent lamps will continue to draw about 16 W.

If the luminaires are in rows and a uniform illuminance is required, remove alternate luminaires in each row rather than all the luminaires in one row. Check the illuminance once the luminaires have been removed.

2. Replace lamps which are beyond their useful life.

A badly blackened fluorescent lamp, for example, will produce just a fraction of its rated light output.

3. Keep the luminaires clean and replace discoloured lenses.

4. Locate the work positions to take advantage of daylight.

SOURCE: Lighting for Education, Ontario Ministry of Education, Toronto, 1981.

APPENDIX E - GENERAL MAINTENANCE

FIGURE E4

RECOMMENDED LIGHTING LEVELS

Table 1: Recommended Illuminances

Classroom	
Kindergarten[1]	350 lux
General classrooms, seminar rooms	500 lux
Visually impaired students	1500 lux
Large group instruction areas (including lecture theatres)[2]	250 lux
Auditorium	
Assemblies only[2]	250 lux
When used for study or examinations	500 lux
Cafeteria	
General	250 lux
Servery	350 lux
Kitchen	500 lux
When used for study or examinations	500 lux
Drafting	
General	500 lux
On boards[3]	1000 lux
Graphic arts	
General	500 lux
On boards[3]	1000 lux
Gymnasium (Gymnatorium and Cafetorium)	
General	250 lux
When used for study or examinations	500 lux
Laboratories	
General	500 lux
Demonstrators' desks	750 lux
Library	
Stacks (with little local reading)	250 lux
Reading, note taking, cataloguing	500 lux
Seminar rooms	500 lux
Offices	500 lux
Music room	500 lux
Sewing[3]	500 lux
Shops[3]	500 lux
Typing	500 lux
Washrooms and locker areas	250 lux
Corridors	
With lockers	250 lux
Without lockers[3]	100 lux
Mechanical and service areas	250 lux
Storage areas	100 lux

Notes:
1. The illuminance of 350 lux has been selected for the kindergarten since the visual tasks are not severe.

2. It should be possible by simple switching to vary the illuminance by 50 per cent either up or down to accommodate note taking or audio visual presentations. Total control by areas is desirable.

3. Local lighting may be used to supplement the general lighting where fine work is to be carried out or feature displays are located. Supplementary lighting is frequently provided for chalkboards. Since study carrels cut off light from the overhead general lighting system, a local lighting luminaire in each carrel is frequently desirable.

available vision research and of lighting practices in other countries. The consensus approach of the IES has been used as the basis for the illuminance recommendations in these guidelines. (See Table 1.)

The previous method of allocating one illuminance as the only one appropriate for a particular visual task has been dropped. Instead, visual tasks are grouped into a series of categories with a range of three illuminances applicable to each category. The appropriate illuminance is selected from the range of three by means of a system of weighting factors. These factors recognize that working speed and accuracy are improved with more light, that more light is needed if contrast in the visual field is poor, and that more light is needed as one gets older. This last point is important if classrooms are to be used by adults as well as by young students.

These weighting factors have been considered in selecting the illuminances for school spaces shown in Table 1.

SOURCE: Lighting for Education, Ontario Ministry of Education, Toronto, 1981.

APPENDIX E - GENERAL MAINTENANCE

FIGURE E5

MANUFACTURERS LITERATURE FOR EFFICIENT SHOWER HEADS

Jenkinson and Company Limited

23 CHAUNCEY AVENUE, TORONTO, ONTARIO, M8Z 2Z2 / (416) 233-6145 / TELEX 06-967674

SUBJECT: Efficient Showerhead - Canadian Building
April 1980 Publication; Page 47

Gentlemen:

In response to your recent inquiry, we are pleased to submit further information for your consideration.

The NEW "Water Pincher" Classic Showerheads are designed to give a high-velocity-low volume flow of water, thus saving water and energy without sacrificing the quality of the shower.

The internal design of the showerheads feature a self-cleaning metering device that meets P.M.I. specifications of 3 U.S. G.P.M. (2.50 Imp. G.P.M.) @ 80 P.S.I. The showerheads give a quality shower at pressures as low as 20 P.S.I.

The CLASSIC series are available in five models which incorporate the same engineered internal parts.

MODEL NO.

01 ABS Black Faceplate - Chrome Shell
Black Swivel Ball - Black Cap.

02 ABS Black Faceplate - Chrome Shell
Chrome Swivel Ball - Black Cap.

03 Same as #02 with Chrome Swivel Brass Ball

12 Clear Acrylic Faceplate - Clear Acrylic
Shell - Chrome ABS Swivel Ball, Chrome Cap.

13 Same as #12 with Chrome Swivel Brass Ball.

The suggested retail price range from the Model No. 01 @ $7.25 to Model No. 13 - $9.75. These showerheads are available in Bulk quantities for commercial application at lower prices than quoted for Suggested Retail.

Jenkinson and Company Limited are the Canadian Manufacturer's Agent for the Classic series of showerheads and market on a national basis through Plumbing Wholesalers and selected Distributors. However, should you have difficulty obtaining a quotation from a local source, we would be pleased to recommend a supplier.

Thank you for your inquiry and we trust, that the Classic showerheads will warrant your consideration for future requirements.

Yours very truly,

JENKINSON AND COMPANY LIMITED

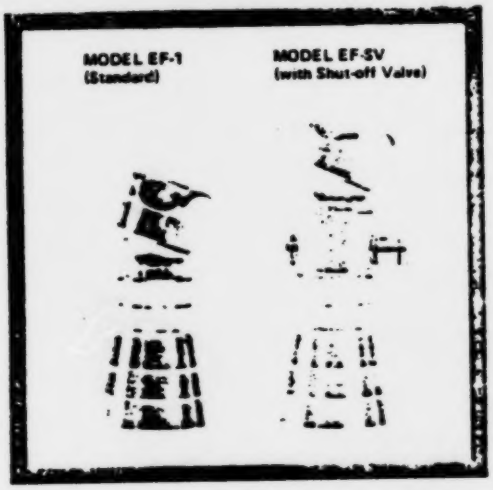
APPENDIX E - GENERAL MAINTENANCE

FIGURE E6

LITERATURE FOR EFFICIENT SHOWER HEADS

ECONO-FLO

SAVES ENERGY AND WATER



You will save up to 75% with our ECONO-FLO shower head and still get a good skin-tingling shower!

The ECONO-FLO shower head uses only 1.5-2 gallons of water per minute (depending upon pressure) compared to the usual 4-8 gallons per minute used by conventional showers, and still provides a forceful, tingling and effective spray.

HOW IS THIS POSSIBLE? The consumption of water is reduced by over 50%, but the water pressure has been doubled in force by a pressure chamber inside the head. In addition, our aerating nozzle mixes air into the water flow giving it a greater bulk.

THE RESULT – A delightful shower at less than half the cost!

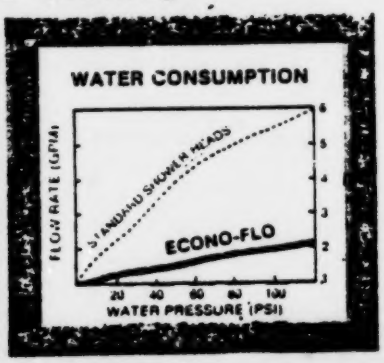
ECONO-FLO is also a problem solver:

PROBLEM #1.
SHORTAGES of hot water will be a thing of the past, since hot water consumption is reduced by over 50%. A family can take 4-5 consecutive showers and still have hot water left over!

PROBLEM #2.
POOR line pressure resulting in limp, lifeless showers is no longer a problem, because ECONO-FLO provides a very satisfactory spray at pressures as low as 20 PSI.

PROBLEM #3.
DAMAGE to tiles, plaster, windowsills and floors, caused by excessive splashing of conventional shower heads, is minimized greatly. Our nozzle aerates the water flow, and when air is mixed with water, splash is virtually eliminated. The water stays in the tub – where it belongs.

- PAYS FOR ITSELF IN AN ASTONISHINGLY SHORT PERIOD OF TIME!
- FORCEFUL, TINGLING SPRAY ENSURES USER SATISFACTION!
- CONSTRUCTED OF SOLID BRASS WITH HEAVY NICKEL-CHROME PLATING FOR MAINTENANCE-FREE OPERATION!
- QUICKLY DISASSEMBLED FOR EASY CLEANING AND REMOVAL OF MINERAL DEPOSITS!
- STANDARD 1/2" PIPE THREAD COUPLING!
- VANDAL-PROOFING FEATURE AVAILABLE FOR INSTITUTIONAL USE. SET SCREWS AT KEY POINTS PREVENT THEFT OR TAMPERING!
- PUSH BUTTON (ALL BRASS) STOP VALVE MODEL PROVIDES SUPER-SAVINGS, ALLOWING USER TO SHUT OFF WATER WHILE LATHERING! IDEAL FOR BOATS, CAMPERS, WATER SHORT LOCATIONS AND RESIDENTIAL APPLICATIONS!
- FULLY WARRANTED FOR ONE FULL YEAR!

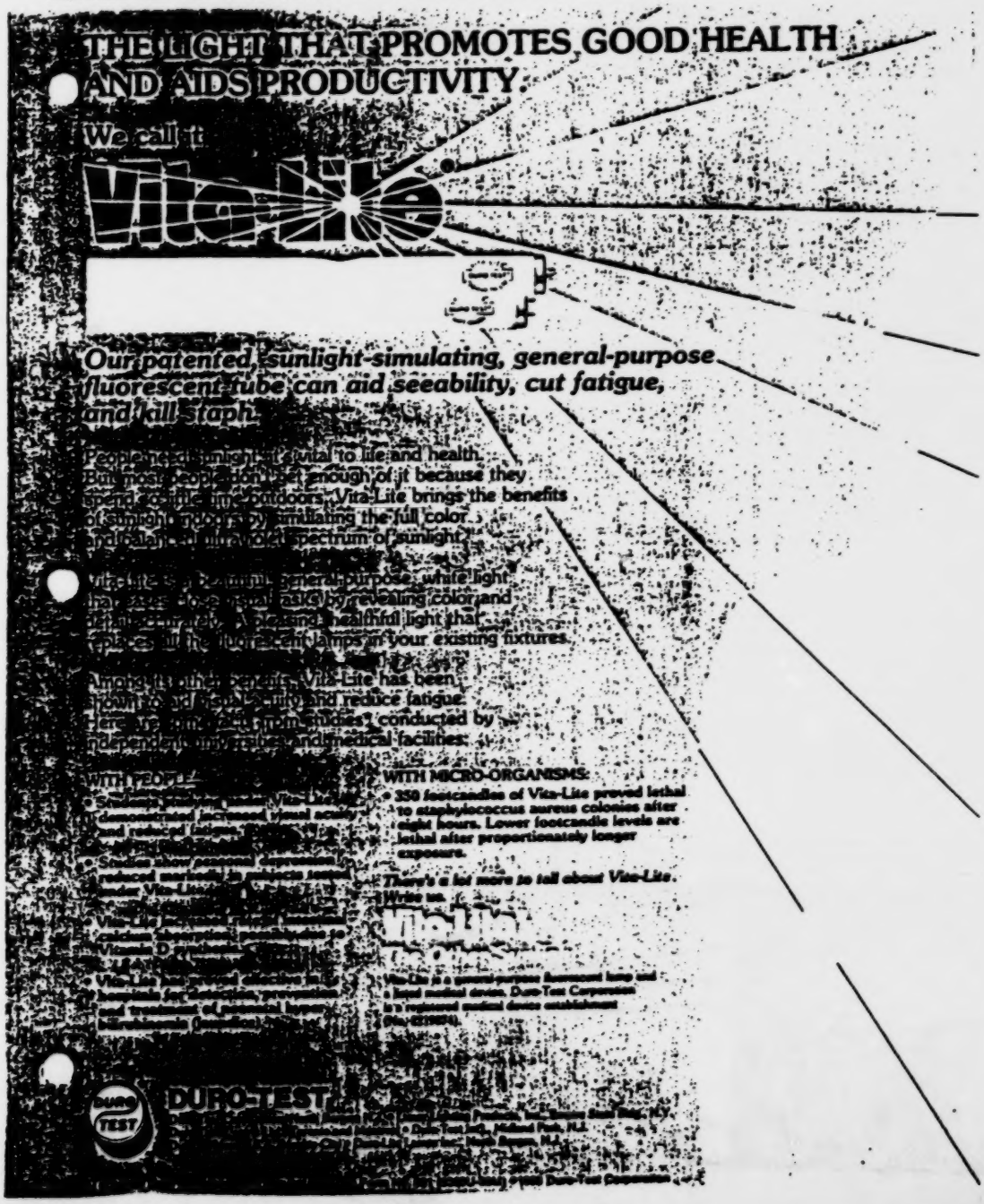


APPENDIX E - GENERAL MAINTENANCE

FIGURE E7

MANUFACTURERS LITERATURE ON VITA-LITE TUBES

Reprinted from *MEDICAL DEVICE AND DIAGNOSTIC INDUSTRY MAGAZINE*, May, 1983


THE LIGHT THAT PROMOTES GOOD HEALTH AND AIDS PRODUCTIVITY.
Vita-Lite
Our patented, sunlight-simulating, general-purpose fluorescent tube can aid seeability, cut fatigue, and kill Staph.
WITH MICRO-ORGANISMS:
• 350 footcandles of Vita-Lite proved lethal to staphylococcus aureus colonies after eight hours. Lower footcandle levels are lethal after proportionately longer exposure.
There's a lot more to tell about Vita-Lite. Write us.
DURO-TEST

APPENDIX E - GENERAL MAINTENANCE

FIGURE E8

MANUFACTURERS LITERATURE ON WATT SAVING LIGHT TUBES

FLUORESCENT WATT-SAVERS.

They slash your light bill as much as 23%.
They maintain 90% of original light levels.
And they last 18,000 to 26,000 user hours.

Don't Turn Off Needed Lights.

Now, simply by replacing your present fluorescent tubes with our Watt-Saver fluorescents, you can greatly reduce your light bills while maintaining 90% (or more) of your original light output. Even at low industrial kWh rates, this can mean a savings of hundreds or even thousands of dollars per month. Often, the power savings can more than pay for the lamps.

The krypton fill-gas used in Watt-Saver fluorescents allows for this wattage reduction because it enhances the energy utilization within the lamp. In addition, an extra aluminum oxide coating, along with a controlled glass-thickness process, assure uniform color and light emission. Lamps stay clean, end to end.

Save on Maintenance, too.

Watt-Saver fluorescents, like all our products, are designed for long burning, so you save on maintenance and replacement costs, as well as on power costs.

Watt-Savers are available in several popular fluorescent colors, plus sunlight-simulating Vita-Lite. Like sunlight, Vita-Lite reveals all details and colors in their true brilliance. It also has been shown to increase visual acuity, reduce fatigue and promote general well-being.

FLUORESCENT WATT-SAVER	REPLACES
34 watts	40 watts
60 watts (Slim)	75 watts (Slim)
95 watts (H.O.)	110 watts (H.O.)
Also! 34W Power-Lite*	40 watts

*With built-in reflector to direct major portion of light downward. Can brighten work area 50% or more, depending on fixture type and lighting conditions. Especially effective in fixtures with poor reflectors or in dusty installations.

The charts below show how much in lighting energy costs you save using Watt-Savers instead of conventional fluorescents over rated life. Example: If you ordinarily burn fifty 75-watt Slims (see 60-watt chart) and your electricity cost is the typical national rate of 7¢ per kilowatt-hour (kWh), Watt-Savers save you $1,190!

Dollar Savings

34 watt using 34W WATT-SAVER fluorescent instead of standard 40W tube over 24,000-hour period

Your ¢ Cost per kWh — $ Savings Shown in Tinted Area

No. of Lamps	12¢	11¢	10¢	9¢	8¢	7¢	6¢	5¢	4¢	3¢
500	$11,520	10,560	9,600	8,640	7,680	6,720	5,760	4,800	3,840	2,880
100	2,304	2,112	1,920	1,728	1,536	1,344	1,152	960	768	576
75	1,728	1,584	1,440	1,296	1,152	1,008	864	720	576	432
50	1,152	1,056	960	864	768	672	576	480	384	288
25	576	528	480	432	384	336	288	240	192	144
15	346	317	288	259	230	202	173	144	115	86
10	230	211	192	173	154	134	115	96	77	58
5	115	106	96	86	77	67	58	48	38	29
4	92	84	77	69	61	54	46	38	31	23
3	69	63	58	52	46	40	35	29	23	17
2	46	42	38	35	31	27	23	19	15	12
1	23	21	19	17	15	13	12	10	8	6

60 watt using 60W WATT-SAVER fluorescent instead of standard 75W slimline over 20,000-hour period

Your ¢ Cost per kWh — $ Savings Shown in Tinted Area

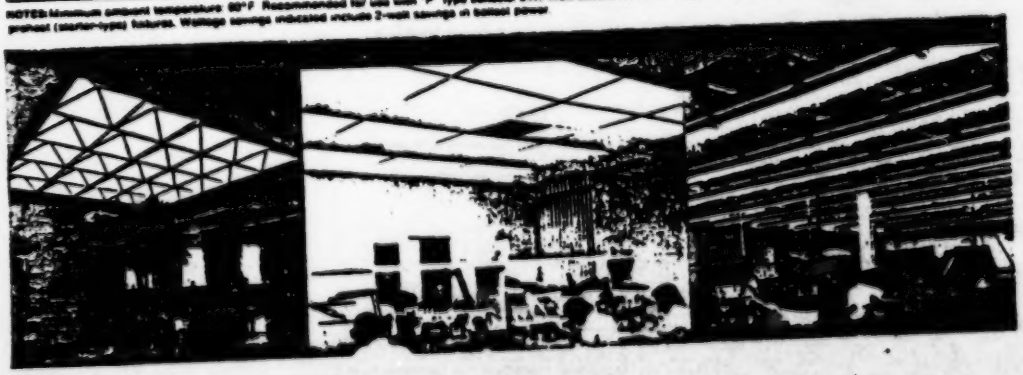
No. of Lamps	12¢	11¢	10¢	9¢	8¢	7¢	6¢	5¢	4¢	3¢
500	$20,400	18,700	17,000	15,300	13,600	11,900	10,200	8,500	6,800	5,100
100	4,080	3,740	3,400	3,060	2,720	2,380	2,040	1,700	1,360	1,020
75	3,060	2,805	2,550	2,295	2,040	1,785	1,530	1,275	1,020	765
50	2,040	1,870	1,700	1,530	1,360	1,190	1,020	850	680	510
25	1,020	935	850	765	680	595	510	425	340	255
15	612	561	510	459	408	357	306	255	204	153
10	408	374	340	306	272	238	204	170	136	102
5	204	187	170	153	136	119	102	85	68	51
4	163	150	136	122	109	95	82	68	54	41
3	122	112	102	92	82	71	61	51	41	31
2	82	75	68	61	54	48	41	34	27	20
1	41	37	34	31	27	24	20	17	14	10

95 watt using 95W WATT-SAVER High Output tube instead of standard 110W H.O. fluorescent over 18,000-hour period

Your ¢ Cost per kWh — $ Savings Shown in Tinted Area

No. of Lamps	12¢	11¢	10¢	9¢	8¢	7¢	6¢	5¢	4¢	3¢
500	$14,580	13,365	12,150	10,935	9,720	8,505	7,290	6,075	4,860	3,645
100	2,916	2,673	2,430	2,187	1,944	1,701	1,458	1,215	972	729
75	2,187	2,005	1,823	1,640	1,458	1,276	1,094	911	729	547
50	1,458	1,337	1,215	1,094	972	851	729	608	486	365
25	729	668	608	547	486	425	365	304	243	182
15	437	401	365	328	292	255	219	182	146	109
10	292	267	243	219	194	170	146	122	97	73
5	146	134	122	109	97	85	73	61	49	37
4	117	107	97	88	78	68	58	49	39	29
3	88	80	73	66	58	51	44	37	29	22
2	58	53	49	44	39	34	29	24	19	15
1	29	27	24	22	19	17	15	12	10	7

NOTES: Minimum ambient temperature 60°F. Recommended for use with "P" type ballasts. 34W Watt-Savers for use in single-lamp or two-lamp rapid start fixtures. Not for use in preheat (starter-type) fixtures. Wattage savings indicated include 2-watt savings in ballast power.



APPENDIX E - GENERAL MAINTENANCE

FIGURE E9

MANUFACTURERS LITERATURE ON LIGHT TUBES

INCREASE WORK-LEVEL LIGHT WITHOUT INCREASING WATTAGE!

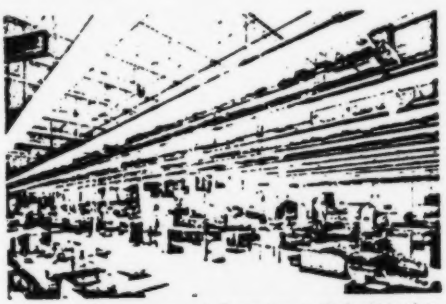
DURO-TEST'S

POWER-LITE®

FLUORESCENT FLOODLIGHT USES EXISTING FIXTURES, BALLASTS, AND CURRENT . . . CAN INCREASE DOWNLIGHT 50% TO 100%.

Directional floodlighting is now possible because fluorescent Power-Lite operates like a regular incandescent floodlite, with a built-in inner reflector. The major portion of the light is directed *downward* to working levels . . . or, when reversed in the fixture, *upward* for an indirect effect.

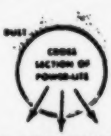
Without consuming a single extra watt . . . without changes in fluorescent ballasts or fixtures . . . without rewiring . . . Power-Lite can actually brighten your work areas from 50% to 100%, depending upon your fixture types and lighting conditions. As an added bonus, Power-Lite is life-rated as high as 24,000 user-hours — saving substantially on maintenance expense.



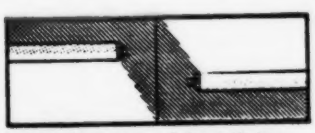
With light aimed downward, Power-Lite is ideal where dust accumulates on top of lamps and in fixtures without reflectors.

AVAILABLE IN WATT-SAVER

In addition to standard 4-foot and 8-foot wattages, Power-Lite is offered in 4-foot Watt-Saver, which saves 15% in electricity.

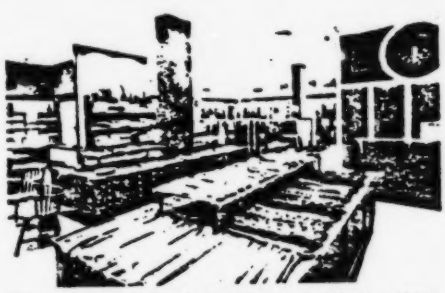


Most light is emitted through bottom, so is unaffected by dust.



Reflector side up directs light downward.

Reflector side down gives indirect lighting effect.



With light aimed upward, Power-Lite gives pleasant, indirect lighting effect . . . reduces fading of merchandise.

DURO-TEST

DURO-TEST CORPORATION 2321 NEWKIRK BLVD NORTH BERGEN NEW JERSEY 07047
SHOPPING CENTERS IN NEW JERSEY GEORGIA ILLINOIS TEXAS AND CALIFORNIA
DURO-TEST INTERNATIONAL
700 GODWIN AVE MIDLAND PARK N.J. 07432
STREET N BLDG 6A EL COMMONWEALTH INDUSTRIAL PARK CAROLINA P.R. 00629-1051
DURO-TEST ELECTRIC LTD
610 ATTWELL DR REXDALE ONTARIO M9W 5W8 • P.O. BOX 236 PLACE BONAVENTURE MONTREAL P.Q. H5A 1B2
DURO DE MEXICO S.A.
PASEO DE LA REFORMA NO 115, 10th PISO MEXICO 5 D.F. MEXICO

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APPENDIX F

COST ANALYSIS OF PROPANE CONVERSION

APPENDIH F - CAMSELL PORTAGE SCHOOL

Cost Analysis of Propane Pulse Condensing Furnaces

2 pulse units installed = 2 x $2,300.00 = $4,600.00

Fuel Savings:

Present oil furnace with a seasonal efficiency of 50% requires 9900L/year which has an energy value of:

38,180 kJ/L x 9900L = 37.8×10^7 kJ/year.

Therefore actual heat required by the building

37.8×10^7 kJ/yr x .5= 18.9 10^7 kJ/year.

Amount of Propane required:

$$\frac{18.9 \times 10^7 \text{ kJ/year}}{.98 \text{ efficiency}} = 19.3 \times 10^7 \text{ kJ/year}$$

$$\text{Litres of propane } \frac{19.3 \times 10^7 \text{ kJ}}{26{,}078 \text{ kJ/L}} = 7{,}395\text{L}$$

Costs= 7395L x $.433/L = $3,202.00

$$\text{Savings: } \frac{\$4{,}550.00 - \$3{,}202.00}{\$4{,}550.00} = 30\%$$

OR

$1,350.00/year - Payback 3.4 years.